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ENGINEERING CHANGE NOTICE

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1. ECN 643830

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. J. H. Rasmussen, Data Assessment and Interpretation, R2-12, 373-1128	4. USQ Required? [] Yes [X] No	5. Date 09/09/98
	6. Project Title/No./Work Order No. Tank 241-BX-110	7. Bldg./Sys./Fac. No. 241-BX-110	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-566, Rev. 0-A	10. Related ECN No(s). ECN-640363	11. Related PO No. N/A

12a. Modification Work [] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. N/A	12c. Modification Work Complete N/A Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change 13b. Design Baseline Document? [] Yes [X] No

The document has been totally revised to include the results of recent sampling to address technical issues associated with the waste, and to update the best basis standard inventory.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Changes required to incorporate new sampling data.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

RELEASE STAMP

DATE: SEP 21 1998

STA: 4

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ID: 2

A-7900-013-2 (05/96) GEF095

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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
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Cog. Eng.	J.H. Rasmussen JRasmussen	9/16/98	PE		
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	J.G. Kristofzski [illegible]	9/21/98	ADDITIONAL		

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Tank Characterization Report for Single-Shell Tank 241-BX-110

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U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: ECN-643830 UC: 2070
Org Code: 74620 Charge Code: N4G4C
B&R Code: EW 3120074 Total Pages: 216

Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-BX-110, Tank BX-110, BX-110, BX Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-BX-110. This report supports the requirements of the Tri-Party Agreement Milestone M-44-15B.

DATE: HANFORD RELEASE
STA: 4
ID: 2
SEP 21 1998

9/21/98

Release Approval Date Release Stamp

Approved for Public Release

RECORD OF REVISION

(1) Document Number: ~~WHC~~ HNF-SD-WM-ER-566 | Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-BX-110

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release: (5) Cog. Engr.	Authorized for Release: (6) Cog. Mgr. Date
0	(7) Initially released 05/22/96 on EDT 615394.	R. D. Schreiber	J. G. Kristofzski
OA RS	Incorporate per ECN-640363.	M. J. Kupfer	K. M. Hodgson
		M J Kupfer 8-25-97	KM Hodgson 8-25-97
1 RS	Incorporate per ECN-643830.	J.H. Rasmussen	K.M. Hall
		J Rasmussen 9/16/98	Kathleen M. Hall 9/16/98

A-7320-005 (08/91) WEF168

HNF-SD-WM-ER-566
Revision 1

Tank Characterization Report for Single-Shell Tank 241-BX-110

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Date Published
September 1998

Prepared for the U.S. Department of Energy
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U.S. Department of Energy under Contract DE-AC06-96RL13200

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LIST OF TERMS

1C	First-cycle $BiPO_4$ waste (contains some CW as neutralizer)
1C1	1C waste produced 1944 to 1949
1C2	1C waste produced from 1950 onward
AES	atomic emission spectroscopy
ANOVA	analysis of variance
BSltCk	Saltcake from evaporation of supernatants in 242-B Evaporator
BYSltCK	Saltcake from ITS of supernatants in BY Farm using in-tank heaters
Btu/hr	British thermal units per hour
Ci/L	curies per liter
Ci	curie
CI	confidence interval
cm	centimeter
cm^3	cubic centimeter
CSRCW	$BiPO_4$ process aluminum cladding waste
CWP	PUREX process cladding waste
df	degrees of freedom
DQO	data quality objective
DSC	differential scanning calorimetry
EB	evaporator bottoms
ft	feet
ft^2	square feet
g/mL	grams per milliliter
g/L	grams per liter
g/cm^3	grams per cubic centimeter
g	gram
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
ITS	in-tank solidification
IX	cesium recovery supernatant (B Plant)
J/g	joules per gram
kg/L	kilograms per liter
kg	kilogram
kgal	kilogallon
kL	kiloliter
kW	kilowatt
LFL	lower flammability limit
m	meter
M	moles per liter

LIST OF TERMS (Continued)

m^2	square meters
mg/L	milligrams per liter
mg	milligram
mg/m^3	milligrams per cubic meter
mR/hr	millirads per hour
n/a	not applicable
n/r	not reported
PHMC	Project Hanford Management Contractor
ppbv	parts per billion by volume
ppm	parts per million
ppmv	parts per million by volume
PUREX	plutonium-uranium extraction [plant]
QC	quality control
REML	restricted maximum likelihood estimation
RPD	relative percent difference
RSD	relative standard deviation
SAP	sampling and analysis plan
SMM	supernatant mixing model
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TSAP	tank sampling and analysis plan
TWRS	Tank Waste Remediation System
W	watt
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
%	percent
μCi/g	microcuries per gram
μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg	microgram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
°C	degrees Celsius
°F	degrees Fahrenheit

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1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize waste in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-BX-110. The objectives of this report are 1) to use characterization data in response to technical issues associated with tank 241-BX-110 waste, and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 shows the best-basis inventory estimate, and Section 4.0 makes recommendations about the tank's safety status and additional sampling needs. The appendices contain supporting data and information. This report supports the requirements of the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1997), Milestone M-44-15b, change request M-44-97-03 to "issue characterization deliverables consistent with the Waste Information Requirements Document developed for 1998."

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. The results of recent sampling events will be used to fulfill the requirements of the data quality objectives (DQOs) and memorandums of understanding specified in *Tank Characterization Technical Sampling Basis* (Brown et al. 1997) for this tank. Other information can be used to support conclusions derived from these results. Appendix A contains historical information for tank 241-BX-110, including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model. Appendix B summarizes sampling events (see Table 1-1), sample data obtained before 1989, and sampling results. Appendix C reports the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is a bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-BX-110 and its respective waste types. The reports listed in Appendix E are available in the Lockheed Martin Hanford Corporation Tank Characterization and Safety Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/Date[1]	Phase	Location	Segmentation	% Recovery
Auger 95-AUG-045 and 95-AUG-046 10/12/95	Solid	Risers 3 and 6	n/a	33% and 45%
Headspace vapor 4/30/96	Gas	Riser 6	n/a	n/a
Headspace flammability 5/21/97	Gas	Headspace	n/a	n/a
Push core 197 5/19/97 to 5/20/97	Solid	Riser 6	2 segments; second segment required two samplers	53%
Push core 198 5/21/97 to 5/22/97	Solid	Risers 3	4 segments, upper half and lower half for segment 2	56%

Notes:

n/a = not applicable

[1]Dates are in mm/dd/yy format.

1.2 TANK BACKGROUND

Tank 241-BX-110 is one of 12 tanks located in the Hanford Site 200 East Area BX Tank Farm. It is the first in a three-tank cascade that includes tanks 241-BX-111 and 241-BX-112. Tank 241-BX-110 went into service in September 1949 when it received first-cycle decontamination waste (1C) from the B Plant bismuth phosphate ($BiPO_4$) process. The supernatant was decanted to the B-039 crib in 1953-1954. In 1954, the tank received supernatant concentrate evaporator bottoms (EB) waste from tank 241-B-105, and in 1957, much of this supernatant was transferred to tank 241-C-111 for the ferrocyanide scavenging campaign. In 1964, plutonium-uranium extraction (PUREX) plant cladding waste from tank 241-C-102 was transferred into tank 241-BX-110, and in 1968, supernatant was removed to tank 241-BX-106. In 1969, the tank received cesium recovery supernatant (IX) waste from the B Plant cesium recovery process, some of which was transferred to tank 241-BX-104 in 1970. In 1972, tank 241-BX-110 received in-tank solidification (ITS) waste (EB waste) from tanks 241-BY-109 and 241-BY-112, and continued receiving this waste until it completed active service. In 1976, the tank was declared "an assumed leaker", and in 1977, it was removed from service. Partial isolation was completed in December 1982 and interim stabilization (August 1985) were completed.

Table 1-2 summarizes the description of tank 241-BX-110. The tank has maximum storage capacity of 2,010 kL (530 kgal), and presently contains an estimated 783 kL (207 kgal) of waste. Of this total estimated volume, 738 kL (195 kgal) is sludge, 34 kL (9 kgal) is saltcake, and 11 kL (3 kgal) is supernatant (Hanlon 1998). The sludge contains 61 kL (16 kgal) of drainable interstitial liquid. The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-BX-110.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1946-1947
In service	1949
Diameter	22.9 m (75.0 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Noncomplexed
Total waste volume[1]	783 kL (207 kgal)
Supernatant volume	11 kL (3 kgal)
Saltcake volume	34 kL (9 kgal)
Sludge volume	738 kL (195 kgal)
Drainable interstitial liquid volume	61 kL (16 kgal)
Waste surface level (May 31, 1998)[2]	201.4 cm (79.3 in.)
Temperature (May 31, 1997 to May 31, 1998)	16.1 °C (61 °F) to 20.9 °C (70°F)
Integrity	Assumed leaker
Watch List	None
Flammable Gas Facility Group	3
SAMPLING DATES	
Auger	October 1995
Headspace vapor	April 1996
Push core	May 1997
SERVICE STATUS	
Declared inactive	1977
Interim stabilization	1985
Intrusion prevention	1982

Notes:

[1]Waste volume is estimated from surface level measurements and photographic evaluations.

2.0 RESPONSE TO TECHNICAL ISSUES

Five technical issues have been identified for tank 241-BX-110 (Brown et al. 1997).

- **Safety screening**: Does the waste pose or contribute to any recognized potential safety problems?
- **Organic complexants**: Does the possibility exist for a point source ignition in the waste followed by a propagation of the reaction in the solid/liquid phase of the waste?
- **Organic solvents**: Does an organic solvent pool exist that may cause a fire or ignition of organic solvents in entrained waste solids?
- **Pretreatment**: What fraction of the waste is soluble when treated by sludge washing and leaching?

The Sampling and Analysis Plan (SAP) (Schreiber 1997a) describes the types of sampling and analysis used to address these technical issues. Data from the analysis of auger samples, push core samples, and tank headspace vapor measurements, along with available historical information, provided the means to respond to the technical issues. Sections 2.1 and 2.2 present the response. Data from the April 1996 vapor sampling provided the means to address the organic solvents issue. See Appendix B for sample and analysis data for tank 241-BX-110.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-BX-110 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each condition is addressed separately below. The requirement in Dukelow et al. (1995) for two widely spaced full cores was not met. Core 197 only penetrated the upper 54 cm (21 in.), or 30 percent of the waste, before sampling was halted by high downforces. Core 198 penetrated the upper 159 cm (59 in.), or 83 percent of the waste, before sampling was halted by activation of the tank bottom detector.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that there are not sufficient exothermic constituents (organic or ferrocyanide) in tank 241-BX-110 to pose a safety hazard. Because of this requirement, energetics in tank 241-BX-110 waste were evaluated. The safety screening DQO required that the waste sample profile be tested for energetics every 24 cm (9.5 in.) to determine whether the energetics exceeded the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated that no sample obtained from tank 241-BX-110 had mean exothermic reactions (on a dry-weight basis) exceeding the safety screening DQO limit. None of the May 1997 core samples exhibited exothermic reactions. Exothermic reactions were noted from each of the October 1995 auger samples. The highest enthalpy change was 44.64 J/g (dry weight basis). The one-sided 95 percent upper confidence limits for auger samples 95-AUG-045 and 95-AUG-046 were 58.0 J/g and 31.6 J/g, respectively. All results were far less than the threshold limit of 480 J/g.

2.1.2 Flammable Gas

Headspace measurements were taken from riser 6 on April 30, 1996 (Evans et al. 1997). The tank 241-BX-110 headspace was analyzed with a combustible gas meter immediately before both the October 1995 auger sampling and the May 1997 push core sampling. The April 30, 1996 vapor sampling event captured vapor samples in evacuated SUMMA[1] canisters and sorbent traps for analysis at the Vapor Analytical Laboratory at Pacific Northwest National Laboratory. Low concentrations of flammable gases (<0.15 percent of the lower flammability limit [LFL]) were detected, including ammonia (63 ppm), nonmethane organic compounds (1.96 mg/m^3), methanol (1.0 ppm), ethanol (0.8 ppm), acetone (0.2 ppm), and lesser quantities of other volatile and semivolatile organics. Flammable gas was not detected by the combustible gas meter tank headspace measurements (0 percent of the LFL) obtained before sampling. All measurements were below the safety screening limit of 25 percent of the LFL.

2.1.3 Criticality

The safety screening DQO (Dukelow et al. 1995) threshold for criticality, based on the total alpha activity, is 1 g/L. Because total alpha activity is measured in μCi/mL for liquids and μCi/g for solids instead of g/L, the 1-g/L limit is converted into units of μCi/mL and μCi/g by assuming that all alpha decay originates from ^{239}Pu. The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu and assuming a density of 1.89 g/mL (the maximum bulk density observed for tank 241-BX-110), 1 g/L of ^{239}Pu is 62 μCi/mL and 32.8 μCi/g of alpha activity. The maximum total alpha activity result from the 1997 core samples was 0.0234 μCi/g (core 198, segment 4). The maximum upper limit to a 95 percent

[1]SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

confidence interval on the mean was 0.0319 μCi/g (core 198, segment 4, lower half), indicating that the potential for a criticality event is extremely low. The maximum total alpha activity in the 1995 auger samples was less than the maximum observed in the 1997 core samples. Auger sample 95-AUG-046 had a mean result of 0.0109 μCi/g and a one-sided 95 percent upper confidence limit of 0.0163 μCi/g. All results were well below the safety screening DQO limits, so criticality is not a concern for this tank. Appendix B presents the total alpha activity analytical data. Appendix C contains the method used to calculate confidence limits.

2.2 ORGANIC COMPLEXANTS

The data required to support the issue of organic complexants are documented in *Memorandum of Understanding for the Organic Complexant Issue Data Requirements* (Schreiber 1997b). The total organic carbon (TOC), total non methane organic compound vapor analysis, energetics by DSC, and sample moisture analyses were conducted to address the organic complexants issue.

2.2.1 Safety Categorization for Organic Complexants

The *Organic Complexant Topical Report* (Meacham et al. 1997b) classifies a tank as safe if the fuel content is less than 4.5 weight percent (wt%) total organic carbon (TOC). Tank 241-BX-110 was categorized as safe by Meacham et al. (1997b) based on an analysis of variance (ANOVA) analysis of the 1995 auger sample TOC data. Additional TOC data obtained during the 1997 core sample event have not yet been incorporated in the ANOVA model. TOC obtained from the 1997 core samples are in all cases lower than those used in Meacham et al. (1997b).

Tank 241-BX-110 is classified as safe using the analysis flowchart in Figure 2 of Schreiber (1997b). Only the two 1995 auger samples exhibited exotherms. The maximum exotherm observed in the 1995 auger samples was 44.64 J/g (dry weight basis) far below the limit of 480 J/g. The seven 1997 core sample segments did not exhibit exotherms. The fraction of solid sample segments exhibiting exotherms is 2/9, or 22 percent. Because the exotherms observed in the auger samples were very small, and because less than 25 percent of the samples exhibited exotherms, the tank is categorized as safe.

2.3 ORGANIC SOLVENTS SCREENING

The data supporting the organic solvent screening issue are documented in *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue* (Meacham et al. 1997a). The organic solvent DQO requires that tank headspace samples be analyzed for total nonmethane organic compounds to determine whether the organic extractant pool in the tank is a hazard. This assessment is performed to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur. Data from the April 1996 vapor sampling of tank 241-BX-110 (Evans et al. 1997) provided a nonmethane organic carbon concentration value that ranged from 1.84 mg/m^3 to 2.13 mg/m^3 in the three tank headspace samples taken, with an average concentration of 1.96 mg/m^3. The threshold limit of concern is the presence of an organic solvent pool greater than 1 m^2 (10.8 ft^2) in area. Using calculations that combine nonmethane organic carbon concentration with tank headspace temperature and tank ventilation rates, Huckaby et al. (1997) calculated the potential organic solvent pool area for tank 241-BX-110 to be 0.10 m^2 (1.1 ft^2). The upper 95 percent confidence limit estimated for the potential pool area was 0.22 m^2 (2.4 ft^2). This is well below the established threshold for this safety issue.

2.4 PRETREATMENT

Samples were archived for future pretreatment analyses and evaluation in accordance with *Strategy for Sampling Hanford Site Tanks for Development of Disposal Technology* (Kupfer et al. 1995).

2.5 OTHER TECHNICAL ISSUES

Vapor samples were also obtained to address the Data Quality Objective for Tank Hazardous Vapor Safety Screening (Osborne and Buckley 1995). However, this issue is being closed because headspace vapor (sniff) tests are required for the safety screening DQO (Dukelow et al. 1995) and the toxicity issue was closed for all tanks (Hewitt 1996). Heat generation and waste temperature are factors in assessing tank safety. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on the 1995 and 1997 sample events was not possible because radionuclide analyses were not required. However, the heat load estimate based on the tank process history was 329 W (1,120 Btu/hr) (Agnew et al. 1997a). The heat load estimate based on the tank headspace temperature was 675 W (2,300 Btu/hr) (Kummerer 1995). Both of these estimates are quite low, and are well below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986).

2.6 SUMMARY

The results of all analyses performed to address potential safety issues showed that primary analytes did not exceed safety decision threshold limits. Some uncertainty exists because neither core 197 nor core 198 included waste from the bottom of the tank. There is, however, no indication that any waste type other than 1C1, 1C2, B1 saltcake (B1SltCk), CWR2, CSR, or BY saltcake (BYSltCk) waste exists in the tank. These waste types have no exothermic constituents and do not represent a safety hazard. The analyses results are summarized in Table 2-1.

Table 2-1. Summary of Technical Issues.

Issue	Sub-issue	Result
Safety screening	Energetics	No exotherms were observed in any core sample. Exotherms in auger samples were well below 480 J/g threshhold.
	Flammable gas	Vapor measurement reported <1 percent of LFL. (Combustible gas meter and vapor samples).
	Criticality	All analyses were well below 32.8 μCi/g total alpha (within 95 percent confidence limit on each sample).
Organic complexants	Safety categorization (Safe)	The tank is categorized as safe because <25% had exotherms and all exotherms were <480 J/g.
Organic solvents	Solvent pool size	The organic solvent pool's size was estimated at 0.10 m^2 (1.1 ft^2), well below the established threshold of 1 m^2 (10.8 ft^2).
Pretreatment	Analyses for treatment to separate low-level and high-level waste streams	Samples were archived for future analysis.

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3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage and disposal.

Chemical and radiological inventory information are generally derived using three approaches: 1) component inventories are estimated using results of sample analyses; 2) component inventories are estimated using the HDW model based on process knowledge and historical information; or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-BX-110 was performed, including the following.

- Analytical data for the 1997 push mode core samples (see Appendix B).

- Analytical data for the 1978 push mode core samples (see Appendix B).

- Analytical and historical model data from five waste tanks (241-BX-107, 241-BX-112, 241-C-110, 241-T-104, and 241-T-107) that contain $BiPO_4$ process 1C solids. These tanks are expected to represent the $BiPO_4$ process 1C waste solids in tank 241-BX-110 and are used as a basis for comparison with the 1978 and 1997 core sample data for the 1C waste layer.

- Analytical data from three waste tanks (241-BY-105, 241-BY-106, and 241-BY-110) that contain BYSltCk waste. These tanks are expected to represent the BYSltCk solids in tank 241-BX-110 and are used as a basis for comparison with the 1997 core sample data for the BYSltCk waste layer.

- Analytical and historical model data from four waste tanks (241-B-104, 241-B-106, 241-B-108, and 241-B-109) that contain BSltCk. These tanks are expected to represent the BSltCk solids in tank 241-B-107 and are used as a basis for comparison with the 1997 core sample data for the BSltCk waste layer.

- An inventory estimate generated by the HDW model (Agnew et al. 1997a).

The results of this evaluation support using a combination of the analytical data from the 1978 and 1997 core samples from tank 241-BX-110 and sample results from other waste tanks as the primary basis for the best-estimate inventory for the tank for the following reasons.

- Sample data, if available, are generally preferable to estimates from tanks with similar wastes or from transfer models.

- The analytical concentrations of components in each of three waste types now estimated to be in the tank (1C, BYSltCk, and BSltCk) generally fall within the ranges observed in other analyses and historical model estimates. However, the sample results for core 198 have characteristics of all three of these waste types and may not be representative of the tank as a whole.

- The results for core 197 are consistent with the BYSltCk layer predicted by the TLM for the corresponding region of the tank.

- The results for the 1978 core sample are consistent with the 1C layer predicted by the TLM for the corresponding region of the tank.

- The results for core 198 core are consistent with the BSltCk layer predicted to reside between the 1C and BYSltCk layers by examination of the waste transfer history (Agnew et al. 1997b).

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. The charge balance approach is consistent with that used by Agnew et al. (1997a).

Mercury inventories for each tank recently have been calculated based on process history (Simpson 1998). The estimate given for tank 241-BX-110 is 49.7 kg of mercury.

Tables 3-1 and 3-2 show the best-basis inventory estimates for tank 241-BX-110. These best-basis inventories are summations of the chemical and radionuclide inventories of the individual 1C, BSltCk, BYSltCk, and supernatant waste types predicted to reside in tank 241-BX-110 from examination of the waste transfer history (Agnew et al. 1997b). The inventory estimates for some chemical components are based on the sample results. For other chemicals, inventory results are partly or entirely based on engineering estimates derived from the average concentration of components in similar tanks. Where no sampling or engineering estimate exists, the HDW model compositions for similar waste types are used. Component concentrations derived from engineering estimates and HDW model derived compositions are adjusted for the density, moisture content, and waste volumes in tank 241-BX-110. Finally, inventories for a small number of components are revised based on process knowledge. Section D3.5 describes the derivation of the chemical inventory. The inventory values in Tables 3-1 and 3-2 are subject to change without notice. Refer to the Tank Characterization Database (LMHC 1998) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997). All radionuclides are reported on a common report date of January 1, 1994, to be consistent with the decay date used in the HDW model. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, have been infrequently reported. Therefore, it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997 and in Watrous and Wootan 1997.) Model-generated values for radionuclides in any of 177 tanks are reported in Agnew et al. (1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result (if available). For a discussion of typical errors between model-derived values and sample-derived values, see Kupfer et al. (1997). As few applicable radionuclide data from the tank 241-BX-110 samples were available, the majority of the radionuclide estimates were derived from reported data for similar tanks and the HDW model. Section D3.5 describes derivation of the radionuclide inventory. Where no sampling or engineering estimate exists, the HDW model radionuclide concentrations for similar waste types are used. Radionuclide concentrations derived from engineering estimates are adjusted for the density, moisture content, and waste volumes in tank 241-BX-110.

Table 3-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-BX-110 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	30,900	S/E	
Bi	26,800	S/E	
Ca	2,600	M/E	
Cl	2,080	S/E	
TIC as CO_3	16,600	S/E	
Cr	5,500	S/E	
F	16,600	S/E	
Fe	20,400	S/E	
Hg	49.7	E	Global reconciliation for all tanks (Simpson 1998)
K	949	S/E	
La	183	S/E/M	
Mn	255	S/E/M	

Table 3-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-BX-110 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Na	2.65E+05	S/E	
Ni	156	S/E/M	
NO_2	24,100	S/E	
NO_3	3.48E+05	S/E	
OH_{TOTAL}	58,200	C	Charge balance
Pb	452	S/E	
PO_4	1.61E+05	S/E	
Si	11,000	S/E	
SO_4	9,840	S/E	
Sr	482	S/E	
TOC	1,680	S/E	
U_{TOTAL}	8,780	S/E	
Zr	179	S/E	

Note:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based, and C = calculated by charge balance; includes oxides as "hydroxide" not including CO_3, NO_2,NO_3, PO_4, SO_4, and SiO_3. In all cases, the analytical data and model results were adjusted for the moisture content and density found in the corresponding region of tank 241-BX-110 during the 1997 core sampling event.

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 Decayed to January 1, 1994 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (Ci)[1]	Basis (S, M, or E)[2]	Comment
^{3}H	21.1	M	
^{14}C	5.47	M	
^{59}Ni	0.596	M	
^{60}Co	5.07	M	
^{63}Ni	59.0	M	
^{79}Se	0.468	M	
^{90}Sr	20,100	S/E	Method varies according to layer (Section D3.5)
^{90}Y	20,100	S/E	Referenced to ^{90}Sr
^{93m}Nb	1.64	M	
^{93}Zr	2.26	M	
^{99}Tc	30.6	M	
^{106}Ru	0.00101	M	
^{113m}Cd	11.8	M	
^{125}Sb	22.7	M	
^{126}Sn	0.700	M	
^{129}I	0.0592	M	
^{134}Cs	0.247	M	
^{137m}Ba	63,500	S/E	Referenced to ^{137}Cs
^{137}Cs	67,100	S/E	
^{151}Sm	1,620	M	
^{152}Eu	0.733	M	
^{154}Eu	85.7	M	
^{155}Eu	44.7	M	
^{226}Ra	2.57E-05	M	
^{227}Ac	3.28E-04	M	
^{228}Ra	0.270	M	
^{229}Th	0.00624	M	
^{231}Pa	0.00163	M	
^{232}Th	0.00998	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 Decayed to January 1, 1994 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (Ci)[1]	Basis (S, M, or E)[2]	Comment
^{232}U	0.0499	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{233}U	0.191	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{234}U	2.60	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{235}U	0.0908	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{236}U	0.0205	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{237}Np	0.104	M	
^{238}Pu	1.58	S/E/M	Method varied by layer. See Section D3.5.
^{238}U	2.78	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{239}Pu	158	S/E/M	Method varied by layer. See Section D3.5.
^{240}Pu	14.5	S/E/M	Method varied by layer. See Section D3.5.
^{241}Am	0.482	S/E/M	Method varied by layer. See Section D3.5.
^{241}Pu	48.3	S/E/M	Method varied by layer. See Section D3.5.
^{242}Cm	8.65E-04	S/E/M	Method varied by layer. See Section D3.5.
^{242}Pu	2.20E-04	S/E/M	Method varied by layer. See Section D3.5.
^{243}Am	7.81E-06	S/E/M	Method varied by layer. See Section D3.5.
^{243}Cm	6.51E-05	S/E/M	Method varied by layer. See Section D3.5.
^{244}Cm	5.38E-05	S/E/M	Method varied by layer. See Section D3.5.

Notes:

[1]All data adjusted for density and water content found during 1998 core sampling event.

[2]S = sample-based, M = HDW model-based, and E = engineering assessment-based.

4.0 RECOMMENDATIONS

Safety screening DQO (Dukelow et al. 1995) issues have been reviewed, and no significant exotherms exist. The flammable gas concentrations are 0 percent of the LFL, and the maximum total alpha activity is a factor of 1,000 times lower than the threshold for criticality. Because none of the core samples and less than 25 percent of the core and auger samples had exotherms, the memorandum of understanding (Schreiber 1997b) indicates that organic complexants are not an issue. The calculated pool size for organic extractants is smaller than the threshold limit of concern (Meacham et al. 1997b)

Table 4-1 summarizes the Project Hanford Management Contractor (PHMC) TWRS Program review status and acceptance of the sampling and analysis results reported in this TCR. All DQO issues required to be addressed by sampling and analysis are listed in column 1 of Table 4-1. Column 2 indicates by "yes" or "no" whether the requirements of the DQO were met by the sampling and analysis activities performed. A "yes" or "no" in column 3 indicates concurrence and acceptance by the program in PHMC/TWRS responsible for the applicable issue. A "yes" in column 3 indicates that no additional sampling or analysis are needed. Conversely, "no" indicates additional sampling or analysis may be needed to satisfy issue requirements.

Because the waste at the bottom of the tank was not sampled (see Section B2.1) the safety screening DQO has been only partially completed. The upper part of the waste was sampled and analyzed in accordance with the safety screening DQO and accepted by the responsible TWRS program.

Table 4-1. Acceptance of Tank 241-BX-110 Sampling and Analysis.

Issue	Sampling and Analysis Performed	PHMC/TWRS Program Acceptance
Safety screening	Partial[1]	Yes
Organic complexant MOU[2]	Yes	Yes
Organic solvents[2]	Yes	Yes
Pretreatment	No (sample archived)	N/A

Notes:
[1]Partial cores retrieved.
[2]The organic solvent and organic complexant issues are expected to be closed in 1998.

Table 4-2 summarizes the status of PHMC/TWRS program review and acceptance of the evaluations and other characterization information contained in this report. Column 1 lists the different evaluations performed in this report. Column 2 shows whether issue evaluations have been completed or are in progress. Column 3 indicates concurrence and acceptance with the evaluation by the program in PHMS/TWRS that is responsible for the applicable issue. A "yes" indicates that the evaluation is completed and meets all issue requirements.

Sampling and analysis for the safety screening issue is listed as "partial" because the full depth of the waste was not sampled. However, none of the analyses indicated any safety problems and no additional sampling is planned at this time.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-BX-110.

Issue	Evaluation Performed	TWRS[1] Program Acceptance
Safety screening DQO	Partial[2]	Yes
Organic complexant analysis[3]	Yes (Safe)	Yes
Organic solvents DQO[3]	Yes	Yes

Notes:

[1]PHMC TWRS Program Office

[2]Partial cores retrieved, additional sampling not recommended.

[3]The organic solvent and organic complexant issues are expected to be closed in 1998.

5.0 REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997b, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 3, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order,* as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Evans, J. C., K. H. Pool, B. L. Thomas, K. B. Olsen, J. S. Fruchter, and K. L. Silvers, 1997, *Headspace Vapor Characterization of Hanford Waste Tank 241-BX-110: Results from Samples Collected on 4/30/96*, PNNL-11256, Pacific Northwest National Laboratory, Richland, Washington.

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending May 31, 1998*, HNF-EP-0182-122, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Hewitt, E. R., 1996, *Tank Waste Remediation System Resolution of Potentially Hazardous Vapor Issues*, WHC-SD-TWR-RPT-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks,* WHC-SD-WM-WP-311, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Huckaby, J. L., and D. S. Sklarew, 1997, *Screening for Organic Solvents in Hanford Waste Tanks Using Organic Vapor Concentrations*, PNNL-11698, Pacific Northwest National Laboratory, Richland, Washington.

Kummerer, M., 1995, *Topical Report on Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-WM-SARR-010, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. W., W. W. Schultz, and J. T. Slankas, 1995, *Strategy for Sampling Hanford Site Tank Wastes for Development of Disposal Technology*, WHC-SD-WM-TA-154, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

LMHC, 1998, Best Basis Inventory for Tank 241-AW-105, Tank Characterization Database, June 30, Internet at http://twins.pnl.gov:8001/TCD/main.html, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997a, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Meacham, J. E., A. B. Webb, N. W. Kirch, J. A. Lechelt, D.A. Reynolds, G. S. Barney, D. M. Camaioni, F. Gao, R. T. Hallen, and P. G. Heasler, 1997b, *Organic Complexant Topical Report*, HNF-SD-WM-CN-058, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Osborne, J. W., and L. L. Buckley, 1995, *Data Quality Objectives for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

Schreiber, R. D., 1997a, *Tank 241-BX-110 Rotary Mode Core Sampling and Analysis Plan*, HNF-SD-WM-TSAP-112, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Schreiber, R. D., 1997b, *Memorandum of Understanding for the Organic Complexant Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Simpson, B. C., 1998, *Best-Basis Inventory Change Package for Reconciliation of Mercury Values, Change Package #7,* (interoffice memorandum 7A120-98-005 to J. W. Cammann, February 26), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Smith, D. A., 1986, *Single-Shell Tank Isolation Safety Analysis Report,* WHC-SD-WM-SAR-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-BX-110 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, and modeling data about the tank. This information is necessary for providing a balanced assessment of sampling and analytical results.

This appendix contains the following information:

- **Section A1.0**: Current tank status, including the current waste levels and the tank stabilization and isolation status
- **Section A2.0**: Information about the tank design
- **Section A3.0**: Process knowledge about the tank, the waste transfer history, and the estimated contents of the tank based on modeling data
- **Section A4.0**: Surveillance data for the tank, including surface-level readings, temperatures, and a description of the waste surface based on photographs
- **Section A5.0**: Appendix A references.

A1.0 CURRENT TANK STATUS

As of December 31, 1997, tank 241-BX-110 contained an estimated 783 kL (207 kgal) of noncomplexed waste (Hanlon 1998). The liquid volume was determined by photographic evaluation and manual tape surface level gauge measurements, and the solids volume was determined using a manual tape surface level gauge. This estimate of tank volume was changed from 749 kL (198 kgal) to 783 kL (207 kgal) in 1994 when a 60-cm-wide by 90-cm-high (2-ft-wide by 3-ft-high) ledge on the perimeter of the tank was taken into account. Table A1-1 shows the volumes of the waste phases found in the tank.

In 1976, tank 241-BX-110 was declared an assumed leaker (with a leak volume of approximately 30 kL [8 kgal]) and removed from service in 1997. It was interim stabilized in 1985; intrusion prevention (interim isolation) was completed in December 1982. The tank is passively ventilated and is not on any Watch List (Public Law 101-510).

Table A1-1. Tank Contents Status Summary.

Waste Type	kL	kgal
Total waste	783	207
Supernatant	11	3
Sludge	783	195
Saltcake	34	9
Drainable interstitial liquid	61	16
Drainable liquid remaining	72	19
Pumpable liquid remaining	49	13

A2.0 TANK DESIGN AND BACKGROUND

The 241-BX Tank Farm was constructed from 1946 to 1947 in the 200 East Area of the Hanford Site, and contains twelve 100-series tanks. These tanks have an operating capacity of 2,010 kL (530 kgal), and are 22.9-m (75-ft)-diameter tanks with a 5.18-m (17-ft) operating depth. Tank 241-BX-110 began operation in September 1949. Built as a first generation design tank farm, the 241-BX Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). A 7.6-cm (3-in.) cascade overflow line connects three tanks together in a step series. Tank 241-BX-110 is first in the three-tank cascade that includes tanks 241-BX-111 and 241-BX-112. The cascade overflow height is approximately 4.6 m (15 ft) from the tank bottom and 60 cm (2 ft) below the top of the steel liner.

Tank 241-BX-110 has a dished bottom with a 1.2-m (4-ft) radius knuckle. Similar to all other single-shell tank farms, the BX Tank Farm tanks are designed with a mild steel primary liner and a concrete dome with various risers. The tank is set on a reinforced concrete foundation, and is covered with approximately 2.4 m (8 ft) of overburden.

Tank 241-BX-110 is equipped with nine risers through the tank dome and two belowgrade manholes. The risers range in diameter from 10 cm (4 in.) to 30 cm (12 in.). The below grade manholes are 1.1 m (42 in.) in diameter. Table A2-1 shows each riser number, size, and description. Figure A2-1 shows the riser configuration. Risers 3 and 6, each 30 cm (12 in.) in diameter, are available for use. Figure A2-2 shows the approximate waste level and a schematic of the tank equipment. Like all single-shell tanks, tank 241-BX-110 is out of service.

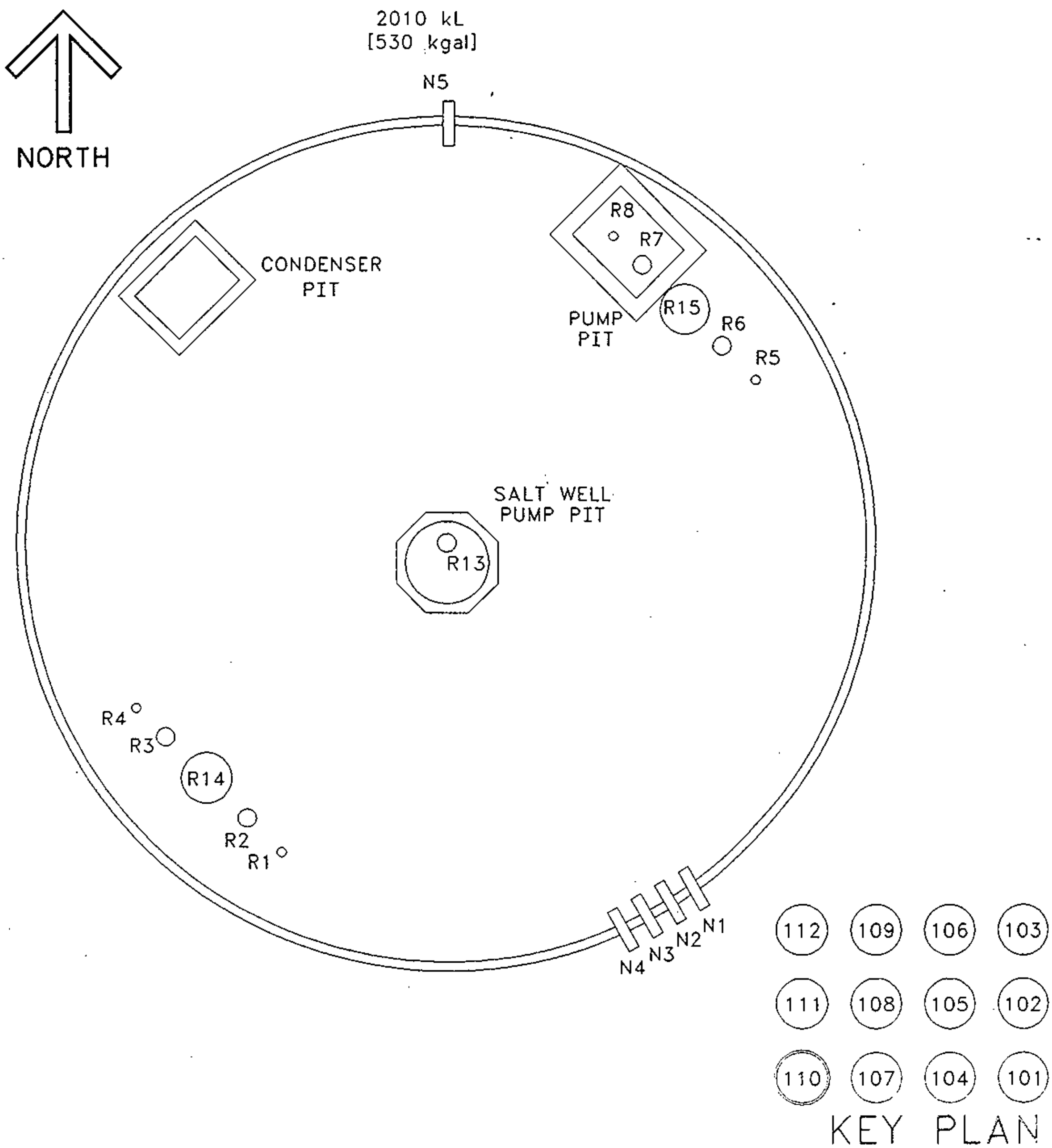
Table A2-1. Tank 241-BX-110 Risers[1,2,3]

New Number	Old Number	Diameter (in.)	Description and Comments
001	R1	4	Temperature probe
002	R2[3]	12	ENRAF[2]
003	R3[3]	12	B-222 observation port
004	R4[3]	4	Breather filter
005	R5[3]	4	Sludge measurement port
006	R6[3]	12	Blind flange
007	R7	12	Pump, weather covered
008	R8	4	Drain, weather covered
013	R13	12	Salt well pump
014	R14	42	Manhole, below grade
015	R15	42	Manhole, below grade
	N1	3	Spare
	N2	3	Inlet line V-344 sealed in diversion box 241-box-153
	N3	3	Inlet line V-343 sealed in diversion box 241-box-153
	N4	3	Inlet line V-342 sealed in diversion box 241-box-153
	N5	3	Overflow

Notes:

[1]Alstad (1993), Tran (1993), Lipnicki (1997), and Vitro (1998)
[2]ENRAF is a trademark of ENRAF Corporation, Houston, Texas.
[3]Denotes risers tentatively available for sampling (Lipnicki 1997)

Figure A2-1. Riser Configuration for Tank 241-BX-110.



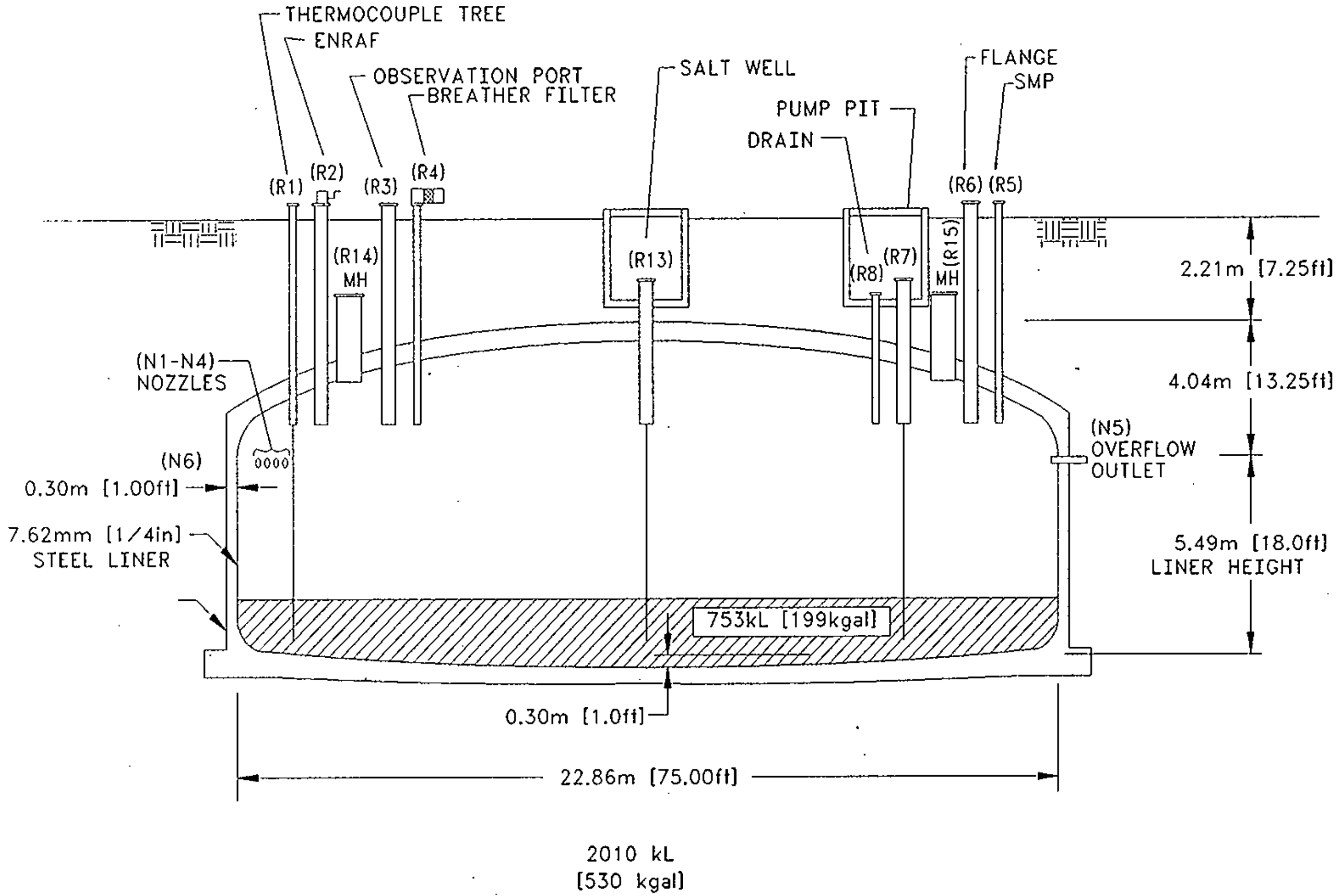


Figure A2-2. Tank 241-BX-110 Cross Section and Schematic.

A3.0 PROCESS KNOWLEDGE

The sections below provide information about the transfer history of tank 241-BX-110, describe the process wastes that made up the transfers, and estimate the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-BX-110 (Agnew et al. 1997b). During the third quarter of 1949, tank 241-BX-110 received 1C waste from the B Plant bismuth phosphate ($BiPO_4$) process. In the first quarter of 1950, the 1C waste started to cascade to tanks 241-BX-111 and 241-BX-112. The cascade ended in the second quarter of 1950. In late 1953 and early 1954, the supernatants were decanted to the B-039 crib. In 1954, tank 241-BX-111 in 1954. Supernatants were transferred to tank 241-C-111 for ferrocyanide scavenging in 1957. The tank received flush water from miscellaneous sources in 1961 and 1968.

In 1964, supernatant was received from tank 241-C-102, which had received PUREX cladding waste. In 1968, supernatant was transferred to tank 241-BX-106. In 1969, tank 241-BX-110 received waste from the B Plant ion exchange process which recovered cesium from various tank wastes. Supernatant was transferred to tank 241-BY-102 in 1969 and to tank 241-BX-104 in 1970. From 1972 to 1973, tank 241-BX-110 supported the in-tank solidification process. Supernatant concentrates were received from tank 241-BY-109 and frequent transfers of this waste type were sent to and from tank 241-BX-110 and tank 241-BY-112 until 1973.

After elevated dry well radiation readings called the integrity of tank 241-BX-110 into question, the tank was declared inactive in the second quarter of 1977. Supernatant was transferred to tank 241-A-102 in 1977 and 1980. Rainwater and snowmelt were inadvertently channeled into tank 241-BX-110 in 1980 via trenches excavated to install salt well transfer lines. In 1983 and 1988 salt well liquor was pumpted to tanks 241-AY-102 and 241-AW-101, respectively.

Table A3-1. Tank 241-BX-110 Major Transfers.[1,2,3,4,5,6]

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[2]	
				kL	kgal
B Plant	--	1C	1949-1950	4,013	1,060
--	Cascade to 241-BX-111	1C	1950	(-1,983)	(-524)
--	B-039 crib	Supernatant	1953-1954	(-1,113)	(-294)
241-B-105	--	EB (242-B)	1954	1,113	294
--	241-BX-111	Supernatant	1954	(-151)	(-40)
--	241-C-111	FeCN Scavenging	1957	(-761)	(-201)
244-BXR	--	Flush water	1961	83	22
241-C-102	--	Supernatant	1964	583	154
--	241-BX-106	Supernatant	1968	(-905)	(-239)
B Plant	--	CSR	1969	867	229
	241-BX-102	Supernatant	1969	(-05)	(-33)
--	241-BX-104	Supernatant	1970	(-1,088)	(-285)
241-BY-109 241-BY-112	--	ITS bottoms	1972-1973	3,267	863
--	241-BY-112	Supernatant	1972-1973	(-2,252)	(-595)
--	241-A-102	Supernatant	1977	(-946)	(-250)
--	241-A-102	Supernatant	1980	(-193)	(-51)
Intrusion		Storm water	1980-1981	30	8
--	241-AY-102 241-AN-101	Supernatant salt well	1983-1988	(-15)	(-4)

Notes:

EB = Evaporator bottoms from the 242-B Evaporator.
1C = First cycle decontamination waste from the B Plant $BiPO_4$ process.
ITS = In-tank solidification.
CSR = Cesium recovery waste from B Plant ion exchange process.

[1]Agnew et al. (1997b)
[2]Anderson (1990)
[3]Brevick et al. (1997)
[4]Rockwell (1980)
[5]Rockwell (1981)
[6]Because of unknown minor transfers, the total volume does not equal the current volume.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for this estimate are from the following sources.

- *Waste Status and Transaction Record Summary: WSTRS, Rev. A*, (Agnew et al. 1997b) is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997a) contains the HDW list, the supernatant mixing model (SMM), the tank layer model (TLM), and the historical tank content estimate (HTCE).

- The HDW list comprises approximately 50 waste types defined by concentration for major analyes/compounds for sludge and supernatant layers.

- The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- The SMM is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

On the basis of these records, the TLM defines the sludge and saltcake layers in each tank. The SMM uses information from the waste status and transaction record summary (WSTRS), the TLM, and the HDW list to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, SMM, and HDW list determine the inventory estimate for each tank. These model predictions are considered estimates that require further evaluation using analytical data.

Based on Agnew et al. (1997a), tank 241-BX-110 contains 219.5 kL (58 kgal) of 1C1 waste, 370.9 kL (98 kgal) of 1C2 waste, and 159 kL (42 kgal) of BYSltCk waste. In comparison with the Hanlon (1998) waste volumes shown in Table 1-2, the HTCE predicts more saltcake, less sludge, and no supernatant are contained in the tank. Figure A3-1 is a graphical representation of the estimated waste types and volumes for the tank layers.

The 1C1 sludge is predicted to contain above one weight percent of sodium, aluminum, iron, hydroxide, nitrate, and phosphate. The constituents predicted to be above 0.1 weight percent for 1C1 waste are bismuth, calcium, nitrite, carbonate, sulfate, and silica. The 1C2 sludge is predicted to contain above one weight percent of sodium, iron, hydroxide, nitrate, nitrite, and phosphate. The constituents predicted to be above 0.1 weight percent for 1C1 waste are aluminum, bismuth, calcium, nitrite, carbonate, sulfate, and silica. For the BY saltcake waste type, the HDW model predicts greater than one weight percent of sodium, aluminum, hydroxide, nitrate, carbonate, sulfate, and nitrite. The constituents predicted to be above 0.1 weight percent for BY saltcake are chromium, phosphate, silica, chloride, citrate, acetate, dibuttyl phosphate, and butanol. The presence of cesium and strontium will give each waste type of modest activity. Table A3-2 shows the historical estimate of the expected waste constituents and their concentrations.

Figure A3-1. Tank Layer Model.

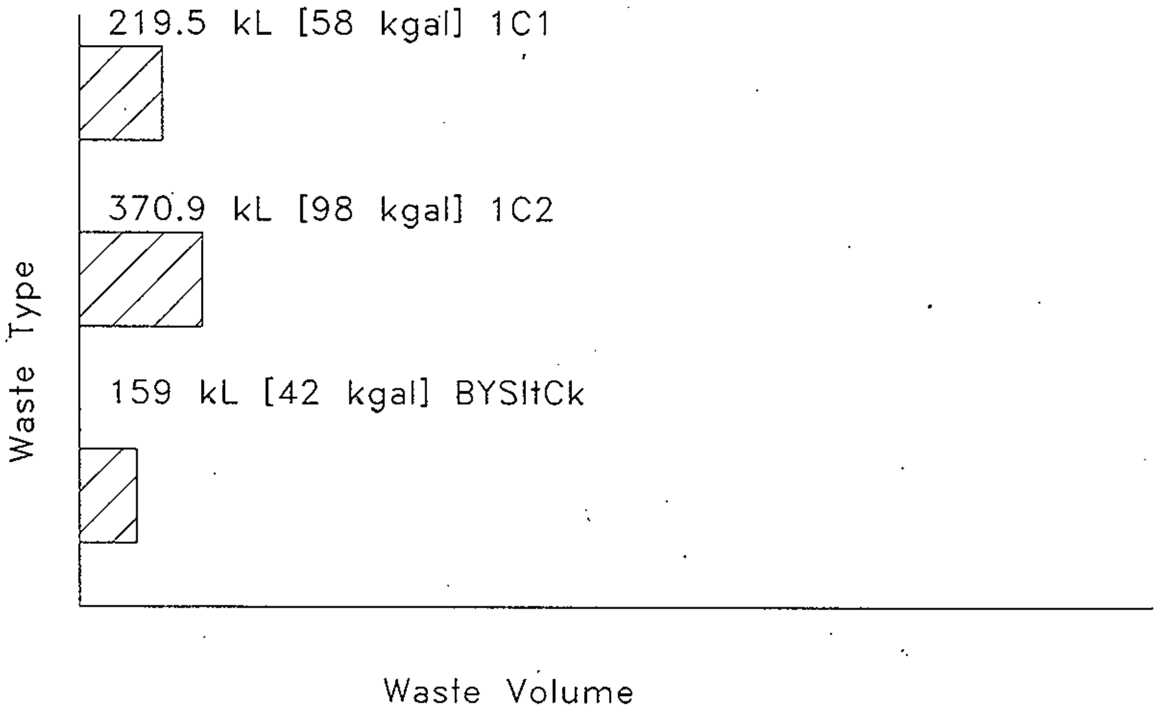


Table A3-2. Historical Tank 241-BX-110 Inventory Estimate.[1,2,3] (4 sheets)

Total Inventory Estimate					
Physical Properties				**-95 CI**	**+95 CI**
Total waste	1.07E+06 kg	(198 kgal)	----	----	----
Heat load	0.329 kW	(1.12E+03 Btu/hr)	----	0.235	0.373
Bulk density[4]	1.42 g/cm^3	----	----	1.33	1.47
Water wt%[4]	58.0	----	----	51.9	64.3
TOC wt% C (wet)[4]	0.109	----	----	9.47E-02	0.116
Chemical Constituents	***M***	**ppm**	**kg[5]**	**-95 CI *M***	**+95 CI *M***
Na^+	6.79	1.10E+05	1.17E+05	5.01	7.97
Al^{3+}	0.838	1.59E+04	1.69E+04	0.583	1.25
Fe^{3+}	0.275	1.08E+04	1.15E+04	0.268	0.278
Cr^{3+}	1.56E-02	569	606	1.32E-02	1.65E-02
Bi^{3+}	4.81E-02	7.08E+03	7.54E+03	3.38E-02	5.28E-02
La^{3+}	4.34E-07	4.24E-02	4.52E-02	3.59E-07	4.43E-07
Hg^{2+}	8.49E-05	12.0	12.8	4.90E-05	9.66E-05
Zr (as ZrO(OH)2)	1.99E-04	12.7	13.6	1.53E-04	2.43E-04
Pb^{2+}	1.20E-03	175	187	6.55E-04	1.75E-03
Ni^{2+}	3.82E-03	158	168	2.84E-03	5.52E-03
Sr^{2+}	0	0	0	0	0
Mn^{4+}	6.88E-04	26.6	28.3	5.07E-04	8.69E-04
Ca^{2+}	7.41E-02	2.09E+03	2.23E+03	4.21E-02	8.47E-02
K^+	1.39E-02	381	406	1.15E-02	1.51E-02
OH^-	4.96	5.93E+04	6.32E+04	3.88	6.58
NO^{3-}	2.18	9.51E+04	1.01E+05	1.40	2.65
NO^{2-}	0.571	1.85E+04	1.97E+04	0.422	0.784
CO_3^{2-}	0.166	7.00E+03	7.46E+03	0.133	0.200
PO_4^{3-}	0.901	6.02E+04	6.41E+04	0.433	1.08
SO_4^{2-}	8.26E-02	5.58E+03	5.94E+03	6.50E-02	0.109
Si (as SiO32-)	0.164	3.25E+03	3.46E+03	9.43E-02	0.214
F^-	0.123	1.65E+03	1.75E+03	9.66E-02	0.265
Cl^-	5.28E-02	1.32E+03	1.40E+03	3.98E-02	5.86E-02

Table A3-2. Historical Tank 241-BX-110 Inventory Estimate.[1,2,3] (4 sheets)

Total Inventory Estimate					
Chemical Constituents (Cont'd)	M	ppm	kg[5]	-95 CI M	+95 CI M
$C_6H_5O_7^{3-}$	5.07E-03	675	718	4.19E-03	5.18E-03
$EDTA^{4-}$	1.14E-03	231	246	1.00E-03	1.16E-03
$HEDTA^{3-}$	1.54E-04	29.6	31.6	4.64E-05	1.96E-04
Glycolate-	3.57E-03	188	201	1.81E-03	4.07E-03
$Acetate^{-}$	6.77E-03	281	300	5.90E-03	6.92E-03
$Oxalate^{2-}$	5.69E-07	3.52E-02	3.75E-02	4.16E-07	6.49E-07
DBP	5.39E-03	797	848	4.64E-03	5.50E-03
Butanol	5.39E-03	281	299	4.64E-03	5.50E-03
NH_3	5.57E-02	666	709	4.52E-02	6.52E-02
$Fe(CN)_6^{4-}$	0	0	0	0	0
Radiological Constituents	Ci/L	μCi/g	Ci[5]	-95 CI (Ci/L)	+95 CI (Ci/L)
^{3}H	2.81E-05	1.98E-02	21.1	4.55E-07	2.87E-05
^{14}C	7.30E-06	5.14E-03	5.47	9.41E-08	7.82E-06
^{59}Ni	7.96E-07	5.60E-04	0.596	2.67E-08	8.61E-07
^{63}Ni	7.87E-05	5.54E-02	59.0	2.42E-06	8.53E-05
^{60}Co	6.77E-06	4.76E-03	5.07	2.20E-08	6.91E-06
^{79}Se	6.25E-07	4.39E-04	0.468	1.98E-08	8.87E-07
^{90}Sr	3.60E-02	25.3	2.69E+04	3.00E-02	3.93E-02
^{90}Y	3.60E-02	25.3	2.70E+04	8.97E-03	3.93E-02
^{93}Zr	3.01E-06	2.12E-03	2.26	9.42E-08	4.31E-06
^{93m}Nb	2.19E-06	1.54E-03	1.64	7.94E-08	3.09E-06
^{99}Tc	4.08E-05	2.87E-02	30.6	2.14E-05	4.64E-05
^{106}Ru	1.35E-09	9.47E-07	1.01E-03	9.50E-15	1.57E-09
^{113m}Cd	1.57E-05	1.10E-02	11.8	2.33E-07	2.33E-05
^{125}Sb	3.03E-05	2.13E-02	22.7	2.07E-08	3.09E-05
^{126}Sn	9.34E-07	6.57E-04	0.700	2.99E-08	1.33E-06
^{129}I	7.90E-08	5.56E-05	5.92E-02	4.12E-08	8.98E-08
^{134}Cs	3.29E-07	2.32E-04	0.247	8.72E-10	3.34E-07

Table A3-2. Historical Tank 241-BX-110 Inventory Estimate.[1, 2, 3] (4 sheets)

Total Inventory Estimate					
Radiological Constituents (Cont'd)	Ci/L	μCi/g	Ci[5]	-95 CI (Ci/L)	+95 CI (Ci/L)
^{137}Cs	4.21E-02	29.6	3.15E+04	2.36E-02	5.07E-02
^{137m}Ba	3.98E-02	28.0	2.98E+04	9.64E-03	4.25E-02
^{151}Sm	2.17E-03	1.52	1.62E+03	7.38E-05	3.06E-03
^{152}Eu	9.78E-07	6.88E-04	0.733	2.90E-08	9.83E-07
^{154}Eu	1.14E-04	8.04E-02	85.7	4.01E-07	1.42E-04
^{155}Eu	5.96E-05	4.20E-02	44.7	2.16E-06	6.00E-05
^{226}Ra	3.43E-11	2.41E-08	2.57E-05	5.22E-12	4.86E-11
^{228}Ra	3.61E-07	2.54E-04	0.270	1.07E-16	3.67E-07
^{227}Ac	4.38E-10	3.08E-07	3.28E-04	2.67E-11	6.99E-10
^{231}Pa	2.18E-09	1.53E-06	1.63E-03	5.82E-11	3.48E-09
^{229}Th	8.33E-09	5.86E-06	6.24E-03	2.08E-14	8.47E-09
^{232}Th	1.33E-08	9.37E-06	9.98E-03	2.67E-17	2.05E-08
^{232}U	2.01E-06	1.41E-03	1.51	9.04E-07	3.32E-06
^{233}U	7.70E-06	5.42E-03	5.77	3.46E-06	1.27E-05
^{234}U	1.24E-05	8.75E-03	9.32	1.13E-05	1.28E-05
^{235}U	5.49E-07	3.87E-04	0.412	5.00E-07	5.66E-07
^{236}U	1.22E-07	8.58E-05	9.14E-02	1.10E-07	1.26E-07
^{238}U	1.32E-05	9.30E-03	9.91	1.21E-05	1.36E-05
^{237}Np	1.39E-07	9.76E-05	0.104	7.70E-08	1.55E-07
^{238}Pu	7.75E-07	5.45E-04	0.581	4.77E-07	1.07E-06
^{239}Pu	5.17E-05	3.63E-02	38.7	2.79E-05	7.05E-05
^{240}Pu	6.28E-06	4.42E-03	4.70	3.95E-06	8.12E-06
^{241}Pu	4.86E-05	3.42E-02	36.5	2.72E-05	7.00E-05
^{242}Pu	2.31E-10	1.63E-07	1.73E-04	1.29E-10	3.34E-10
^{241}Am	9.63E-06	6.78E-03	7.22	3.48E-06	1.49E-05
^{243}Am	3.28E-10	2.31E-07	2.46E-04	1.02E-10	5.43E-10
^{242}Cm	6.59E-10	4.64E-07	4.94E-04	5.37E-10	6.78E-10
^{243}Cm	1.35E-11	9.50E-09	1.01E-05	1.10E-11	1.39E-11
^{244}Cm	7.48E-11	5.27E-08	5.61E-05	3.16E-11	8.64E-11

Table A3-2. Historical Tank 241-BX-110 Inventory Estimate.[1,2,3] (4 sheets)

Total Inventory Estimate					
Totals	*M*	μg/g	kg[5]	-95 CI (*M* or g/L)	+95 CI (*M* or g/L)
Pu	7.85E-04 (g/L)	----	0.588	3.92E-04	1.10E-03
U	0.158	2.64E+04	2.81E+04	0.143	0.162

Notes:

CI = confidence interval

[1]Agnew et al. (1997a)

[2]These predictions have not been validated and should be used with caution.

[3]Unknowns in tank solids inventory are assigned by the TLM.

[4]This is the volume average for density, mass average water wt%, and TOC wt% C.

[5]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

A4.0 SURVEILLANCE DATA

Tank 241-BX-110 surveillance consists of surface-level measurements (liquid and solid) and temperature monitoring inside the tank (waste and headspace), and leak detection well (drywell) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate whether the tank has a major leak and can also detect liquid intrusions into the tank. Solid surface-level measurements indicate physical changes in and consistencies of the solid layers of a tank. Drywells located around the tank perimeter may show increased radioactivity caused by leaks.

A4.1 SURFACE-LEVEL READINGS

The waste surface level for tank 241-BX-110 was measured by a manual tape until June 1996. An automatic ENRAF™ surface-level gauge has monitored the waste surface level since June 1996. On May 1, 1998, the waste surface level was 2.01 m (79.3 in.), as measured by the automatic ENRAF™ system. Figure A4-1 shows the volume measurements as a level history graph. It should be noted that the ENRAF™ system reports surface levels referenced to the lowest point on the dished tank bottom. This is 0.31 m (12 in.) below the reference point used by the manual tape measurements, and causes the ENRAF™ system to report surface levels 0.31 m (12 in.) higher than the corresponding manual tape measurement.

Tank 241-BX-110 is categorized as an assumed leaker, and has been isolated from all liquid sources. The automatic ENRAF™ gauge on riser 2 is used to monitor the surface level for liquid intrusion. The maximum allowable deviation from the baseline surface level is an increase of 7.62 cm (3 in.). Because the tank contains mostly salt cake and sludge, the surface level readings are not monitored for decreases, and are not relied upon for leak detection (Hanlon 1998).

The waste surface level, which has remained steady for the past three years, ranges between 2.00 and 2.02 m (78.8 and 79.5 in.).

Two occurrence reports were issued because of liquid level increases. The January 1980 report attributed the increase to rapid snowmelt runoff though a pump pit under construction, and the January 1981 report attributed the increase to precipitation through a riser in the pump pit. In both cases, trenches excavated for installation of salt well transfer piping channeled the runoff toward tank 241-BX-110.

A4.2 INTERNAL TANK TEMPERATURES

Tank 241-BX-110 has a single thermocouple tree in riser 1 which contains 14 thermocouples to monitor the tank temperature. Since May 1994, daily temperature readings are available for thermocouples 1, 2, 3, 4, 7, and 11. Temperature data are available from October 14, 1971, to May 31, 1998 from the Surveillance Analysis Computer System (LMHC 1998) (SACS). Thermocouple 1 is 40 cm (1.3 ft) from the bottom of the tank. Thermocouples 2 through 12 are at 60 cm (2 ft) intervals above thermocouple 1. Thermocouples 13 and 14 are at 122 cm (4 ft) intervals above thermocouple 12. Thermocouples 1 through 3 are in the waste. The remaining thermocouples are in the vapor space.

The average temperature for the SACS data is 18.4°C (65.1 °F), the minimum temperature is 12.8 °C (55 °F), and the maximum temperature is 51.7 °C (125 °F). The average temperature per the SACS data over the past year (May 31, 1997 to May 31, 1998) was 18.2 °C (64.7 °F) the minimum was 16.1 °C (61 °F) and the maximum was 20.9 °C (69.6 °F). The highest temperature on May 31, 1998 was 17.6 °C (63.7 °F) on thermocouple 1 and the minimum was 16.7 °C (62.6 °F) on thermocouple 4. A graph of the weekly high temperatures can be found in Figure A4.2. Plots of the individual thermocouple readings can be found in the *BX Tank Farm Supporting Document for the Historical Content Estimate* (Brevick et al. 1997).

A4.3 TANK 241-BX-110 PHOTOGRAPHS

Photographs of the tank interior are available from the Tank Characterization and Safety Resource Center and from the Vidon photo/video library. Tank 241-BX-110 has been photographed on numerous occasions over the years, but not all photographs referred to anecdotically in historical documentation are available at this time. In particular, the photographs of the drill string during the 1978 core sampling event, which would be of great utility in understanding the conditions encountered during the 1997 core sampling event, have not been located.

The July 1994 photographic montage of tank 241-BX-110's interior reveals translucent pools of liquid (mostly in the center) on an irregular solid surface of saltcake that appears to be on top of sludge. A heavy coating of light-colored saltcake clings to the tank perimeter. Visible equipment and debris include a manual tape, a thermocouple tree, both salt well screens, and several nozzles. Currently, tank 241-BX-110 contains 783 kL (207 kgal) of waste (Hanlon 1998). It is unclear whether additional supernatant pumping has taken place since the photograph date. Considering the small amount of supernatant in question, the photograph should accurately show the tank contents even if supernatant was pumped from the tank after the photographs were taken. To account for the saltcake on the tank perimeter (the saltcake is estimated to be 61 cm [2 ft] wide by 91 cm [3 ft] high), a volume adjustment was made in October 1994. An in-tank video was taken October 13, 1994.

A4.4 TANK 241-BX-110 DRYWELL READINGS

Tank 241-BX-110 has no liquid observation well, but it has five identified dry wells. Dry wells 21-10-01, 21-10-03, and 21-10-05 were active before 1990 and have readings greater than 200 counts/second. These readings are consistent with the classification of tank 241-BX-110 as an assumed leaker.

Figure A4-1. Tank 241-BX-110 Level History.

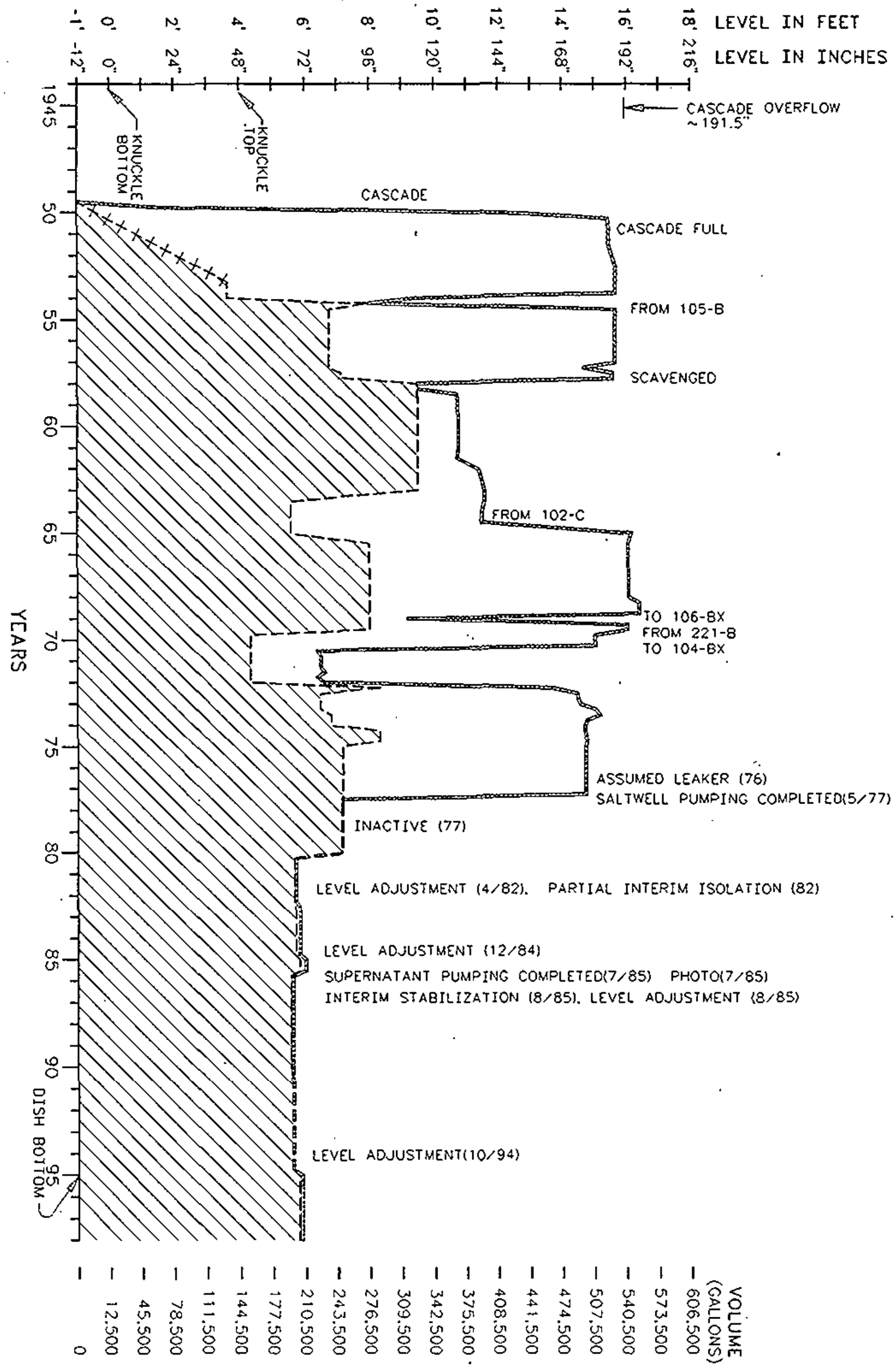
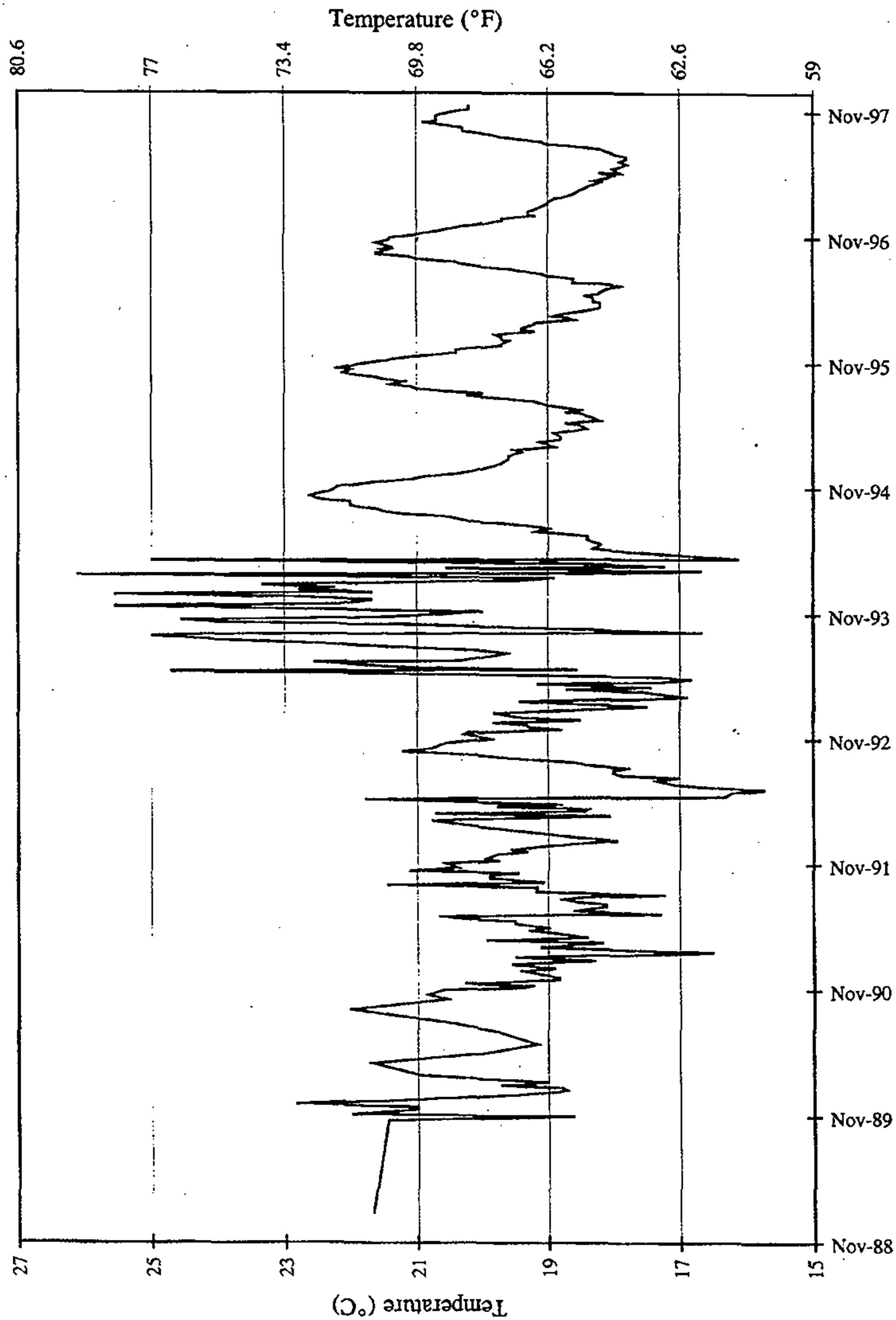


Figure A4-2. Tank 241-BX-110 High Temperature Plot.



A5.0 APPENDIX A REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1997b, *Waste Status and Transaction Record Summary (WSTRS) Rev. 4*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-RE-TI-053, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and A. C. Walsh, 1997, *Supporting Document for the Historical Tank Content Estimate for BX Tank Farm*, WHC-SD-WM-ER-311, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1998, Waste Tank Summary Report for Month Ending (May 31, 1998) HNF-EP-0182-122, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, HNF-SD-WM-TI-710, Rev. 4, Numatec Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

Rockwell, 1980, *Tank 110-BX Liquid Level Measurement (Manual Tape) Exceeding the Increase Criterion*, (Report 80-4, January 22), Rockwell Hanford Operations, Richland, Washington.

Rockwell, 1981, *Tank 110-BX Liquid Level Measurement and Apparent Surface Liquid Increase*, (Report 81-04, January 30), Rockwell Hanford Operations, Richland, Washington.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Vitro, 1988, *Piping Waste Tank Isolation 241-BX-110*, H-2-73312, Rev. 6, Vitro Engineering Corporation, Richland, Washington.

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APPENDIX B

SAMPLING OF TANK 241-BX-110

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APPENDIX B

SAMPLING OF TANK 241-BX-110

Appendix B provides sampling and analysis information for each known sampling event for Tank 241-BX-110 and assesses the core sample results. Appendix B includes the following.

- **Section B1.0**: Tank Sampling overview
- **Section B2.0**: Sampling Events
- **Section B3.0**: Assessment of Characterization Results
- **Section B4.0**: Appendix B References

Future sampling information for Tank 241-BX-110 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the sampling and analysis events for Tank 241-BX-110. The recent sampling events used for characterization (auger, vapor, and push mode) are listed in Table B2-1, along with respective data quality objectives for each sample. The auger sampling event was directed by *Tank 241-BX-110 Auger Sampling and Analysis Plan* (Schreiber 1995b). The sampling and analysis plan that directed the vapor sampling was *Vapor Sampling and Analysis Plan* (Homi 1995). The push mode core sampling was directed by *Tank 241-BX-110 Rotary Mode Core Sampling and Analysis Plan* (Schreiber 1997c). Historical sample events, including the 1975 liquid sample, 1976 liquid sample, 1978 core sample, 1990 grab sample, and 1993 grab sample, are briefly described as well, but are of limited use for characterization because of incomplete information regarding sample collection, analytical techniques, and quality control (QC) parameters. Further discussions of the sampling and analysis procedures can be found in *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

B2.0 SAMPLING EVENTS

This section describes sampling events for tank 241-BX-110. Tables B2-10 through B2-53 show analytical results. Section B2.1 describes the 1997 core sampling event. Section B2.2 describes the 1996 vapor sampling event. Section B2.3 describes the 1995 auger sampling event. Section B2.4 describes grab sample events. Historical sample events are described in Section B2.5. The analytical results used to characterize current tank contents were the 1978 core sample, 1995 auger sample, 1996 vapor sample and 1997 core sample. Table B2-1 summarizes the sampling and analytical requirements from the applicable DQOs.

B2.1 1997 CORE SAMPLING EVENT

This section describes the May 1997 core sampling and analysis events for tank 241-BX-110. Push core samples were taken to satisfy the requirements of *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), and *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements* (Schreiber 1997b). The sampling and analyses were performed in accordance with the *Tank 241-BX-110 Rotary Mode Core Sampling and Analysis Plan* (Schreiber 1997c). That document, called a tank sampling and analysis plan (TSAP), also specified that if enough samples were recovered, composite material would be retained for pretreatment studies as guided in the *Strategy for Sampling Hanford Site Tank Wastes for Development of Disposal Technology* (Kupfer et al. 1995). Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

Two full vertical core samples from tank 241-BX-110 were sought to meet the safety screening DQO. The tank was originally scheduled to be core sampled by rotary mode, but push mode sampling was employed because the material was expected to be mostly soft, wet sludge overlain with a layer of saltcake that was readily penetrated during the 1995 auger sampling event. Two push mode core samples were collected from risers 3 and 6 of tank 241-BX-110. However, neither riser 3 nor riser 6 yielded a full core as specified in the TSAP (Schreiber 1997c). No lithium bromide solution was used during sample collection.

Core 197 was obtained on May 19 and 20, 1997. The core was to have consisted of one 25-cm (10-in.) segment and three 48-cm (19-in.) segments taken from the material directly below riser 6. However, the 2,000-lb high downforce limit was reached 15 cm (6 in.) into segment 2, and the sampler was removed from the tank. The downforce limit was increased to 2,900-lb, and sampling resumed as segment 2A. Sampling of riser 6 was terminated when the 2,900-lb downforce limit was encountered 19 cm (7.5 in.) into segment 2A. The nature of the obstruction beneath riser 6 is not known. The presence of pipes, tapes, sludge weights, and other debris on the waste surface, as in-tank photos show, gives rise to the suspicion that

Table B2-1. Integrated Data Quality Objective Requirements for Tank 241-BX-110.

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push mode core sampling May 1997	Safety screening - Energetics - Moisture content - Total alpha - Flammable gas (Dukelow et al. 1995) Organic complexants memorandum of understanding[1] (Schreiber 1997b)	Full-depth core samples from a minimum of two risers separated radially to the maximum extent possible Combustible gas measurement	Flammability, energetics, moisture, total alpha activity, density, anions, cations, radionuclides, TOC, separable organics
	Disposal technology (Kupfer et al. 1995)	Core samples from sludge layer	Archive
Vapor sampling April 1996	Hazardous vapor[1] (Osborne and Buckley 1995)	Steel canisters, triple sorbent traps, sorbent trap systems	Flammable gas, organic vapors, permanent gases
	Organic solvents[1] (Meacham et al. 1997)	Headspace vapor samples	Total nonmethane hydrocarbons
Auger sampling October 1995	Safety screening - Energetics - Moisture content - Total alpha - Flammable gas (Dukelow et al. 1995) Organics[1] (Turner 1995)	Core samples from a minimum of two risers separated radially to the maximum extent possible Combustible gas measurement	Energetics, moisture content, density, total alpha activity, TOC, separable organics

Note:

[1]This issue was applicable at the time of sampling, but is either closed out or will be closed out in the near future.

similar debris may be present below the surface. Alternatively, the sampler may have encountered a region of hard saltcake. Segment 2A's low moisture content is consistent with the presence of a hard saltcake layer. Similar difficulties penetrating the saltcake layer were encountered during the November 1978 core sampling event (Jungfleisch 1980). Extrusions for core 197 were performed on June 2, 1997.

Core 198 was obtained from riser 3 on May 21 and 22, 1997. The core was to have consisted of one 25-cm (10-in.) segment and three 48-cm (19-in.) segments taken from the material directly below riser 3, but the tank bottom detector tripped, limiting segment 4 to 33 cm (13 in.). The sampler passed easily through the waste, requiring a maximum downforce of only 1,100 lb for segment 2. Extrusions for core 198 were performed June 2 through June 5, 1997.

A possible explanation for the relative ease of penetrating the waste below riser 3 compared to that below riser 6 is the extensive disturbance of the waste during the November 1978 core sampling event. Jungfleisch (1980) stated that the drill string was rotated in a "whip" condition (the tip was spinning in an arc of about 50 cm [20 in.]) and lowered over 200 cm (79 in.) into the waste. A search of documentary and photographic records failed to determine which riser was subjected to this treatment. The July 30, 1985 in-tank photographs show a circular depression in the waste below riser 3, but it is not possible to confirm whether the waste below riser 3 was indeed the location sampled and disturbed in the November 1978 sampling event.

Only the safety screening DQO (Dukelow et al. 1995) and organic complexant memorandum of understanding (Schreiber 1997b) were applicable to the solid samples at the time of sampling. Safety screening and organic complexant analytes are listed in Table B2-1. Organic complexant analytes include TOC to determine the amount of organic carbon present, and DSC to measure the fuel energy of the waste. Additional analyses were conditional on the decision logic in Schreiber (1997b), and were not required because of the absence of exotherms in the DSC analyses. Opportunistic analyses included inductively coupled plasma spectrocopy (ICP) and ion chromatography (IC). The full range of analytes was obtained for both ICP and IC analyses. Analyses that correspond to the analytes listed are found in Table B2-2.

Table B2-2. Tank 241-BX-110 Subsampling Scheme and Sample Description.[1]

Core: Segment	Sample ID	Weight (g)	Sample Portion	Sample Description
Core 197, Riser 6				
197:1	197-01	114.3	Drainable liquid	Bluish gray and opaque. Separated into two layers, dark green liquid phase on top of bluish gray liquid.
		196.4	Solids, lower half	Bluish gray. Resembled a wet salt.
197:2	197-2	75.1	Drainable liquid	Bluish gray and opaque
		90.1	Solids, lower half	Bluish gray. Resembled a wet salt.
197:2A	197-2A	221.0	Drainable liquid	Light green and opaque
		51.8	Solids, lower half	Light green. Resembled a wet salt.
Core 198, Riser 3				
198:1	198-1	98.9	Drainable liquid	Clear and colorless
198:2	198-2	58.8	Drainable liquid	Brownish green and opaque
		115.3	Solids, upper half	Yellowish brown. Resembled a wet salt.
		216.3	Solids, lower half	Yellowish brown. Resembled a wet salt.
198:3	198-3	34.6	Drainable liquid	Brown and opaque.
		284.2	Solids, lower half	Yellowish brown. Resembled a wet salt.
198:4	198-4	282.6	Solids, lower half	Light brown. Resembled a sludge slurry.

Note:

[1]Nuzum (1998)

B2.1.1 Sample Handling

The TSAP (Schreiber 1997c) states that core samples should be transported to the laboratory within three calendar days from the time each segment is removed from the tank. This requirement was not met for either core.

The riser 6 sample, core 197, segments 1, 2, and 2A, arrived at the 222-S Laboratory on May 29, 1997. Extrusion on June 2, 1997 revealed that segment 1 contained 15 cm (6 in.) of bluish-gray saltcake and 114.3 g of liquid. The liquid separated into two phases after sitting several hours in the collection jar. The small amount of dark green liquid floating on the remaining bluish-gray liquid portion was subsampled and analyzed by DSC, thermogravimetric analysis (TGA), IC, and ICP. Segment 2 yielded 8 cm (3 in.) of bluish-gray saltcake and 75.1 g of bluish-gray, opaque liquid. Segment 2A contained 5 cm (2 in.) of light green, wet salt and 221.0 g of light green, opaque liquid. Table B2-2 gives the subsampling scheme and sample description for the core sample.

The riser 3 sample, core 198, segments 1, 2, 3, and 4, arrived at the 222-S Laboratory on May 29 and 30, 1997. Extrusion on June 2 through June 5, 1997 revealed that segment 1 contained 98.9 g of opaque, brownish green liquid and no solids. Segment 2 yielded 33 cm (13 in.) of yellowish brown salt and 58.8 g of opaque brown liquid. The solid portion of segment 2 was divided into a 115.3-g upper half and a 216.3-g lower half for analysis. Segment 3 yielded 23 cm (9 in.) of yellowish brown salt and 34.6 g opaque brown liquid. Segment 4 yielded 28 cm (11 in.) of light brown sludge slurry and no drainable liquid. Table B2-2 gives the subsampling scheme and sample description for the core sample.

B2.1.2 Sample Analysis

The analyses performed on the core samples were limited to those required by the safety screening DQO and the organic complexant memorandum of understanding (Schreiber 1997b). The analyses required by the safety screening DQO included analyses for thermal properties by DSC, moisture content by TGA, organic carbon by persulfate oxidation (for solid samples only), density by gravimetry and content of fissile material by total alpha activity analysis. The organic complexant memorandum of understanding required energetics by DSC, moisture content by TGA, and total organic carbon by persulfate oxidation. Lithium analyses by ICP and bromide analyses by IC were required by the TSAP to detect the intrusion of hydrostatic head fluid in the event that lithium bromide-containing hydrostatic head fluid was used. Moisture content by gravimetry and by near infrared spectroscopy were requested by the TSAP to support method development work, but the request was canceled prior to analysis of the samples (Schreiber 1997a).

Differential scanning calorimetry and TGA were performed on samples ranging in size from 6.360 mg to 55.550 mg. Quality control tests included performing the analyses in duplicate and using standards.

Total alpha activity measurements were performed on samples that had been fused in a solution of potassium hydroxide and then dissolved in nitric acid. The resulting solution was dried on a counting planchet and counted in an alpha proportional counter. Quality control tests included standards, spikes, blanks, and duplicate analyses.

Ion chromatography was performed on samples that had been prepared by water digestion. Quality control tests included standards, spikes, blanks, and duplicate analyses. The TSAP required only measuring the bromide content of the samples. A full suite of IC analytes was obtained opportunistically.

Inductively coupled plasma spectrometry was performed initially on samples that had been prepared by fusion with potassium hydroxide, followed by dissolution in nitric acid. Quality control tests included standards, blanks, spikes, and duplicate analyses. The SAP required only measuring the lithium content of the samples. A full suite of IC analytes was obtained opportunistically.

Total organic carbon was analyzed for the solid samples by the persulfate oxidation method. Total inorganic carbon analyses were obtained opportunistically in conjunction with the TOC analyses.

All reported analyses were performed according to approved laboratory procedures. Table B2-3 lists procedure numbers and applicable analyses.

Table B2-4 is a summary of the sample portions, sample numbers, and analyses performed on each sample.

Table B2-3. Analytical Procedures[1]. (2 sheets)

Analysis	Method	Procedure Number
Energetics	Differential scanning calorimetry	LA-514-114
Moisture	Thermogravimetric analysis	LA-514-114
Total alpha activity	Alpha proportional counter	LA-508-101
Flammable gas	Combustible gas analyzer	WHC-IP-0030 IH 1.4 and IH-2.1[2]
TIC/TOC	Persulfate coulometry	LA-342-100
Metals by ICP/AES	Inductively coupled plasma spectroscopy	LA-505-151 LA-505-161
Anions by IC	Ion chromatography	LA-533-105

Table B2-3. Analytical Procedures[1]. (2 sheets)

Analysis	Method	Procedure Number
Density (solids)	Bulk density by gravimetry	LO-160-103
Density (liquids)	Specific gravity by gravimetry	LA-510-112

Notes:

AES = atomic emission spectroscopy

[1]Nuzum (1998)

[2]Safety Department Administrative Manuals, Westinghouse Hanford Company, Richland, Washington:
IH 1.4, Industrial Hygiene Direct Reading Instrument Survey
IH 2.1, Standard Operating Procedure, MSA Model 260 Combustible Gas and Oxygen Analyzer

Table B2-4. Tank 241-BX-110 Sample Analysis Summary. (2 sheets)

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
6	Core 197, segment 1	Drainable liquid, lower half	S97T001277	Specific gravity, ICP, IC, TGA, DSC, alpha
		Drainable liquid, upper half	S97T001418	ICP, IC, TGA, DSC
		Solids, lower half	S97T001260	Bulk density
			S97T001262	TIC/TOC, DSC/TGA, DSC
			S97T001280	ICP, alpha
			S97T001283	IC
6	Core 197, segment 2	Drainable liquid	S97T001278	Specific gravity, ICP, IC, TGA, DSC, alpha
		Lower sample	S97T001263	Bulk density
			S97T001269	TIC/TOC, TGA, DSC
			S97T001281	ICP, alpha
			S97T001284	IC

Table B2-4. Tank 241-BX-110 Sample Analysis Summary. (2 sheets)

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
6 (Cont'd)	Core 197, segment 2A	Drainable liquid	S97T001279	Specific gravity, ICP, IC, TGA, DSC, alpha
		Solids, lower half	S97T001264	Bulk density
			S97T001270	TIC/TOC, TGA, DSC
			S97T001282	ICP, alpha
			S97T001285	IC
3	Core 198, segment 1	Drainable liquid	S97T001322	Specific gravity, ICP, IC, TGA, DSC, alpha
	Core 198, segment 2	Drainable liquid	S97T001323	Specific gravity, ICP, IC, TGA, DSC, alpha
		Solids, upper half	S97T001299	Bulk density
			S97T001305	TIC/TOC, TGA, DSC
			S97T001308	ICP
			S97T001311	IC
		Solids, lower half	S97T001298	Bulk density
			S97T001304	TIC/TOC, DSC/TGA, DSC
			S97T001307	ICP, alpha
			S97T001310	IC
	Core 198, segment 3	Drainable liquid	S97T001324	Specific gravity, ICP, IC, TGA, DSC, alpha
		Solids, lower half	S97T001300	Bulk density
			S97T001306	TIC/TOC, TGA, DSC
			S97T001309	ICP, alpha
			S97T001312	IC
	Core 198, segment 4	Solids, lower half	S97T001325	Bulk density
			S97T001326	TIC/TOC, TGA, DSC
			S97T001328	ICP, alpha
			S97T001329	IC

B2.1.3 Analytical Results

This section summarizes the sampling and analytical results associated with the May 1997 sampling and analysis of Tank 241-BX-110. Table B2-5 indicates which Appendix B tables contain the total alpha activity, percent water, energetics, IC, ICP, TIC, TOC, and density analytical results associated with this tank. These results are documented in Nuzum (1998).

Table B2-5. Tank 241-BX-110 1997 Core Sample Analytical Tables.

Analysis	Table Number(s)
Total alpha activity	B2-41
Percent water	B2-40
Differential scanning calorimetry	B2-39
Cations by ICP	B2-10 to B2-30
Anions by IC	B2-30 to B2-37
Density by gravimetry	B2-38
Total organic carbon	B2-43
Total inorganic carbon	B2-42

The four QC parameters assessed in conjunction with tank 241-BX-110 samples were standard recoveries, spike recoveries, duplicate analyses (relative percent differences [RPDs]), and blanks. The QC criteria are specified in the TSAP (Schreiber 1997c). Sample and duplicate pairs, in which any QC parameter was outside these limits, are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, or f as follows.

- "a" indicates the standard recovery was below the QC limit.
- "b" indicates the standard recovery was above the QC limit.
- "c" indicates the spike recovery was below the QC limit.
- "d" indicates the spike recovery was above the QC limit.
- "e" indicates the RPD was above the QC limit.
- "f" indicates blank contamination.

In the analytical tables in this section, the "mean" is the average of the result and duplicate value. All values, including those below the detection level (denoted by "<") were averaged. If both sample and duplicate values were nondetected, or if one value was detected while the other was not, the mean is expressed as a nondetected value. If both values were detected, the mean is expressed as a detected value.

B2.1.3.1 Total Alpha Activity. Analyses for total alpha activity were performed on the samples recovered from tank 241-BX-110. Solid samples were prepared by fusion digestion. Two fusions were prepared for each sample (for duplicate results). Each fused dilution was analyzed twice, and the results were averaged and reported as one value. The highest result returned was 0.0234 μCi/g. One drainable liquid sample exhibited alpha activity above the detection limit, with a result of 0.00501 μCi/mL.

The RPD between sample and duplicate for the lower half of segment 1 of core 197 was 32.7 percent, and is attributed to the sample's low alpha activity. Rerun analyses were not requested. Spike recoveries for the lower half of segment 1 of core 197 and for the lower half of segment 4 of core 198 were 65.4 percent and 70.0 percent, respectively. In both cases the spike recovery was well within method control limits for the standard. Rerun analyses were not requested. One of the preparation blanks showed total alpha activity above the detection limit. The level in the preparation blank is inconsequential when compared to sample results, and does not impact sample data quality.

B2.1.3.2 Thermogravimetric Analysis. Thermogravimetric analysis measures the mass of a sample as its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. A decrease in the weight of a sample during TGA represents a loss of gaseous matter from the sample, through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 to 390 °F]) is caused by water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well.

Core 197, segment 2A (sample S97T001270) measured considerably less water than the remaining samples. Inspection of the thermogram revealed that the weight loss curves for the sample were integrated to near 200 °C (390 °F), and no additional significant weight loss occurred up to 450°C (842 °F). Therefore, it is concluded that this salt sample is dryer than other solids analyzed from this tank. The low moisture content may have contributed to the difficulty of obtaining a core sample of this material.

B2.1.3.3 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the sample is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically, and the energy absorbed or released is integrated digitally by an algorithm resident within the instrument.

The DSC analyses for tank 241-BX-110 were performed using a Perkin-Elmer[1] DSC 7 instrument. An unusual exothermic reaction was noted at 70°C (158 °F) for the lower half of segment 2 of core 198. This reaction was attributed to the presence of a cleaning agent in the DSC chamber. Second and third analyses were performed in duplicate, and in both cases, neither the sample nor the duplicate exhibited an exotherm at 70°C. Initially, the gap between closely spaced endotherms was erroneously integrated as an exotherm for a number of samples. A re-run of sample S97T001304 at a lower scanning speed demonstrated that the "exotherm," which never actually crossed the baseline, was actually a gap between two endotherms. Careful reexamination of the data confirmed that no actual exothermic reactions were detected in any of the samples. Therefore, an upper limit of a 95 percent confidence interval on the mean for each sample was not calculated.

B2.1.3.4 Inductively Coupled Plasma. Solid samples were prepared by fusion. Liquid samples were prepared by acid dilution. Although no LiBr-containing hydrostatic head fluid was employed for these samples, Li was reported in accordance with the TSAP. No lithium was detected. No exceptions to the QC parameters for Li were noted. The values for other ICP analytes were included as "opportunistic" without the prescribed QC parameters. Potassium and nickel results for the ICP fusion analyses are not reported, because the samples were prepared in a nickel crucible by fusion using potassium hydroxide.

B2.1.3.5 Ion Chromatography. Solid samples were prepared by water digestion. Although no LiBr-containing hydrostatic head fluid was employed for these samples, Br was reported in accordance with the TSAP. No Br was detected. No exceptions to the QC parameters for the bromide were noted. The values for other IC anions were included as "opportunistic" without the prescribed QC parameters.

B2.1.3.6 Total Inorganic Carbon. Total inorganic carbon analytical data were obtained opportunistically as a byproduct of total organic carbon analyses by the persulfate oxidation method for solid subsamples. The RPD between sample and duplicate for core 198, segment 4 was 23.2 percent, which may reflect sample inhomogeneity.

B2.1.3.7 Total Organic Carbon. Analyses were performed using the persulfate oxidation method for solid subsamples. The RPD between sample and duplicate exceeded 20 percent for four subsamples of core 198. The RPDs for core 198, segments 2 (upper and lower half), 3, and 4 were 89.2, 71.0, 51.6, and 23.9 percent, respectively, which may reflect sample inhomogeneity.

B2.1.3.8 Density. Densities of solid and liquid samples were determined gravimetrically.

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[1]Perkin Elmer is a registered trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, California.

B2.2 APRIL 1996 VAPOR SAMPLE EVENT

Headspace vapor samples were obtained from tank-241-BX-110 on April 30, 1996. This sampling was conducted in accordance with the hazardous vapor DQO (Osborne and Buckley 1995). The sampling event is described in Caprio (1997). The sample analysis and analytical results are described in detail in Evans et al. (1997). Samples were obtained using sorbent trains for selected inorganic analytes, triple sorbent traps for semivolatile organic analytes, and SUMMA™ canisters for permanent gases and volatile organic analytes. Samples were transported to the Pacific Northwest National Laboratory Vapor Analytical Laboratory for analysis. Total nonmethane organic coupound results from these vapor samples were used by Huckaby et al. (1997) to estimate the solvent pool area in accordance with the organic solvent DQO (Meacham et al. 1997). Detailed results are given in Table B2-44.

B2.3 OCTOBER 1995 AUGER SAMPLING EVENT

During the October 1995 sampling and analysis event for tank 241-BX-110, auger samples were obtained from two widely spaced risers to partially satisfy the requirements of Dukelow et al. (1995). The sampling and analyses were performed in accordance with Schreiber (1995b). Although tank 241-BX-110 was not on any Watch List, it had been identified in *Operation Specifications for Watch List Tanks* (WHC 1995a) as a possible Watch List tank because of organics. Consequently, the analytical requirements of Turner (1995) were applied.

Auger samples from two risers were collected from tank 241-BX-110 on October 12, 1995. Sample 95-AUG-045 was collected from riser 6, and was extruded on October 18, 1995 at the 222-S Laboratory. Sample 95-AUG-046 was collected from riser 3, and was extruded on October 19, 1995 at the 222-S Laboratory. The auger samples represent only the top approximately 30 cm (12 in.) of waste in the tank. Although the applicable DQOs would not be fully satisfied, the auger sampling of tank 241-BX-110 was done to determine whether any organics had permeated the saltcake waste material after the tank was stabilized. For this sampling event, the 50.8-cm (20-in.) auger was used. This auger has 20 flutes, each of which is 2.5 cm (1 in.) wide. Flute 1 is at the top of the auger, and flute 20 is near the bottom (the bit).

To address flammable vapor issues, Dukelow et al. (1995) requires sampling of the tank headspace. Before removal of the tank 241-BX-110 auger samples, vapor samples were obtained from the tank headspace and analyzed using a combustible gas meter. Dukelow et al. (1995) specifies that the flammability, as a percent of the LFL, must not exceed 25 percent. The results of this analysis are provided in Section B2.3.3.6.

B2.3.1 October 1995 Auger Sample Handling

Sample 95-AUG-045 had a total of 125.7 g of solid material recovered from the top half of the auger. The material was a grayish blue crystalline solid, similar to crushed ice. An opaque, grayish blue drainable liquid accompanied the solid material, but the liquid was not retained because of insufficient volume. Sample archiving of the solid material was performed in accordance with the TSAP (Schreiber 1995b).

Sample 95-AUG-046 had a total of 185.2 g of solid material recovered from the bottom half of the auger. Flutes 9 through 13 contained a grayish blue granular material, and flutes 14 through 20 contained brown sludge. Because the waste types could not be separated from each other, all solids were subsampled into one jar. A cloudy, brown liquid accompanied the solid material, but the liquid was not retained because of insufficient volume. In addition to the solid and liquid material, a small piece of cloth, covered with brown sludge, was recovered from the auger. The solid samples were archived according to the SAP, and the cloth was archived as directed by the Safety Program.

Table B2-6 lists the sample numbers, sample locations (riser number), drill string dose rates, mass, and visual characteristics of the samples.

Table B2-6. Tank 241-BX-110 1995 Auger Subsampling Scheme and Sample Description.[1]

Riser	Drill String Dose Rate (mR/hr)	Mass (g)	Flute(s)	Sample Characteristics
Sample 95-AUG-045				
6	45	125.7	1 through 8	Grayish blue crystalline solid
Sample 95-AUG-046				
3	140	185.2	9 through 13	Grayish blue granular solid
			14 through 20	Brown sludge

Note:
[1]Schreiber (1995a)

B2.3.2 1995 Auger Sample Analysis

The analyses performed on the auger samples were limited to those required by the safety screening and organic DQOs. These include analyses for thermal properties by DSC, moisture content by TGA, fissile content by total alpha activity analysis, bulk density, and fuel content by TOC analysis. Although not required by either the safety screening or the organic DQOs, analytical results for total inorganic carbon (TIC) were obtained on an opportunistic basis in accordance with Kristofzski (1995). The TGA and DSC analyses were performed on aliquots ranging in size from 14 to 53 mg. Before analyzing for total alpha activity, the samples were prepared by a fusion procedure using potassium hydroxide. A liquid aliquot of the fused sample was then dried on a counting planchet and measured for alpha activity using an alpha proportional counter. Samples were analyzed for TOC by the direct persulfate oxidation/coulometry method.

Laboratory control standards, matrix spikes, blanks, and duplicate analysis quality control checks were applied to the TOC, TIC, and total alpha activity analyses. Laboratory control standards and duplicate analysis quality control checks were used for the DSC and TGA analyses. An assessment of the quality control procedures and data is provided in Section 5.1.2.

All reported analyses were performed in accordance with approved laboratory procedures. Table B2-7 contains a list of the sample numbers and applicable analyses, and Table B2-8 gives the analytical procedures by title and number. No deviations or modifications were noted by the laboratory.

Table B2-7. Tank 241-BX-110 1995 Auger Sample Analysis Summary.[1]

Riser	Sample Identification	Sample Number	Analyses
6	95-AUG-045	S95T002903	DSC, TGA, TOC, TIC
		S95T002905	Bulk density
		S95T002906	Total alpha activity
3	95-AUG-046	S95T002945	DSC, TGA, TOC, TIC
		S95T002946	Total alpha activity
		S95T002948	Bulk density
Flammable gas concentration[2]		n/a	Combustible gas meter

Notes:
[1]Hardy (1998)
[2]WHC (1995b)

Table B2-8. Analytical Procedures for 1995 Auger Samples.[1]

Analysis	Instrument	Preparation Procedure	Analytical Procedure
Energetics by DSC	Mettler™	n/a	LA-514-113
Percent water by TGA	Mettler™	n/a	LA-560-112
Total alpha activity	Alpha proportional counter	LA-549-141, Rev. D-0	LA-508-101
TOC, TIC	Direct persulfate oxidation/coulometry	n/a	LA-342-100
Bulk density	Centrifuge	n/a	LO-160-103
Flammable gas[2]	Combustible gas meter	n/a	TO-080-500

Notes:

Mettler is a registered trademark of Mettler Electronics, Anaheim, California

[1]Hardy (1998)
[2]WHC (1995b)

B2.3.3 1995 Auger Sample Results

The analyses performed on the October 1995 auger samples were limited to those required by the safety screening DQO (Dukelow et al. 1995) and the organic DQO (Turner 1995). Sample extrusion and analyses were performed at the Westinghouse Hanford Company 222-S Laboratory. Table B2-9 identifies the tables that show the total alpha activity, total carbon, density, percent water, energetics, and headspace flammability results associated with this tank. The sample results were reported in Hardy (1998).

Table B2-9. Tank 241-BX-110 1995 Auger Analytical Data Tables.

Analysis	Table Number
Total alpha activity	B2-45
Total organic carbon	B2-46
Total inorganic carbon	B2-47
Density	B2-48
Percent water	B2-49
Differential scanning calorimetry	B2-50

Overall means were calculated for total alpha activity, TOC, TIC, density, and weight percent water. These means were derived by averaging the primary/duplicate means from each auger. If a result was reported as less than the detection limit, the detection limit was used as the result in these calculations. A relative standard deviation (RSD) of the mean was also calculated for analytes, but not for density. The RSD (mean) is defined as the standard deviation of the mean divided by the overall mean, multiplied by 100. The four quality control parameters assessed with the tank 241-BX-110 samples were spike recoveries, standard recoveries, duplicates, and blanks. The data table footnotes in Section 4 indicate quality control deviations for specific samples.

B2.3.3.1 Total Alpha Activity. Analyses for total alpha activity were performed on the auger samples recovered from tank 241-BX-110. The samples were prepared by fusion digestion and measured using an alpha proportional counter. All tank 241-BX-110 total alpha activity results were below or near the instrument detection limit.

B2.3.3.2 Total Carbon. Analyses for TOC and TIC were performed on the 1995 auger samples; TOC as required by Turner (1995), and TIC on an opportunistic basis in accordance with Kristofzski (1995). Analyses for TOC were performed on auger samples S95T002903 and S95T002945. The direct persulfate oxidation/coulometry method was used for the analyses.

B2.3.3.3 Density. Analyses for density were performed on both auger samples. The overall mean was derived by averaging the two sample means.

B2.3.3.4 Thermogravimetric Analyses. During a TGA run, the mass of a sample is measured while its temperature is increased at a constant rate. A gas, such as nitrogen or air, is passed over the sample during heating to remove any gaseous matter. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample through evaporation or a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 to 390 °F]) is caused by water evaporation. The temperature limit for moisture loss is chosen by the responsible chemist at an inflection point on the TGA plot. Other volatile matter fractions often can be differentiated by inflection points as well. Weight percent water by TGA was performed by the 222-S Laboratory under a nitrogen purge using a Mettler instrument in accordance with procedure LA-560-112, Rev B-0.

The analytical results of the two auger samples agreed with an RPD of 30.1 percent. The mean TGA result for sample S95T002903 was 44.45 weight percent water; and for sample S95T002945, the mean result was 32.83 weight percent.

B2.3.3.5 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the substance is exposed to a linear increase in temperature. While the substance is heated, a gas such as nitrogen is passed over the sample to remove any gasses being released. The onset temperature for an endothermic event (characterized by or causing the absorption of heat) or exothermic event (characterized by or causing the release of heat) is determined graphically. The DSC analyses for the tank 241-BX-110 auger samples were performed by the 222-S Laboratory using procedure LA-514-113, Rev. C-0 under a nitrogen atmosphere.

The data table shows the DSC results on a wet weight basis. The temperature range and the magnitude of the enthalpy change are provided for each transition. The first transition represents the endothermic reaction associated with the evaporation of free and interstitial water. The second transition probably represents the energy (heat) required to remove bound water from hydrated compounds such as aluminum hydroxide, or to melt salts such as sodium nitrate. The third transition is generally exothermic, and probably is caused by the fuel components of the sample reacting with nitrate salts.

B2.3.3.6 Tank Headspace Flammability. Vapor samples were taken from the tank 241-BX-110 headspace before auger sampling to satisfy the requirements of Dukelow et al. (1995). As specified in the DQO, the flammability of the headspace cannot exceed 25 percent of the LFL. During this sampling event, readings were 0 percent of the LFL (WHC 1995b), indicating no flammability concerns.

B2.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

B2.4.1 Description of the 1993 Grab Sampling Event

A grab sampling event occurred in 1993. One sample was obtained, but attempts to retrieve other samples were unsuccessful. The results are not considered representative of the waste because the constituent concentrations were much lower than the 1990 sample results. Further, the results were very different from those of the two tank 241-BX-111 grab samples taken during 1993. The tank 241-BX-111 sample results, however, were similar to the 1990 results from tank 241-BX-110, which was expected because the two tanks were used for similar purposes during their fill cycles (Sutey 1993). For these reasons, this data set has not been included in this tank characterization report.

B2.4.2 Description of 1990 Grab Sampling Event

In early 1990, laboratory results were reported for one liquid grab sample (it is hypothesized that this sample was obtained in late 1989). Although the reason for sampling is unknown, the analyses performed indicate that it was for compatibility purposes. Analyses included a number of metals, anions, and radionuclides, as well as TOC and some physical properties.

No information is available about the exact date, riser, or analytical procedures used during the project, and, consequently, these results should be used with caution. Table B2-51 provides the analytical results for the listed analytes.

B2.4.3 Description of the 1978 Core Sampling Event

Tank 241-BX-110 was sampled in 1978 with a split-tube core sampler. Three 50-cm (20-in.) core segments were obtained, of which only the bottom segment (#3) contained sufficient material to analyze. The description of this rotary-mode sampling event in Jungfleisch (1980) provides insight into the characteristics of the tank 241-BX-110 waste:

> Tank 241-110-BX was sampled, with difficulty, through an apparently hard structure for the first two 50-cm cores (sample tubes #1 and #2). Sample recovery was virtually zero (a few crystals), but, on examination the sample tubes had apparently been full of liquid. Prior to the third core (several days delay), the drill rod plugged and had to be withdrawn from the waste surface and blown free. Upon reentry into the hole, the drill rod with sample tube (#3) was lowered slowly in a non-rotary mode. The rod passed the 100-cm depth, on to 150 cm to 200 cm, and stopped at the approximate 250 cm maximum depth. During this single slow penetration of the entire tank depth no resistance was met. The sample tube (#3) ... contained 41 cm of soft sludge and 5 to 10 cm of supernate.
>
> Suspecting a floating "crust", the rod was withdrawn to above the waste, rotated to a "whip" condition (the rod tip spinning in an arc of about 50 cm). The spinning rod was then lowered slowly to probe for the previously encountered hard salt cake layer. However, the hard layer was not encountered and the sampling proceeded unimpeded into the salt cake to a depth over 200 cm...In tank photos taken subsequent to the above efforts revealed a full salt cake crust over the entire tank, occasionally broken by a broken pool of liquid. The drill rod was centered in a hole in the crust approximately 55 cm in diameter.

The "whip" action of the spinning core drill string may have intermixed the saltcake and sludge layers in the 50-cm (20-in.)-diameter region directly below the sample riser. While the in-tank photos referred to in the excerpt from Jungflesich (1980) have not been located, the 1985 in-tank photos clearly show a shallow, circular depression below riser 3. If riser 3 is, indeed, the location of the 1978 sample event, this might explain the low resistance offered by the waste when obtaining core 198 in May 1997. For further discussion of the sampling event, refer to Jungfleisch (1980) where the author speculates about the nature and depth of the waste based on several attempts to sample the tank. His conclusion, which is that the waste is composed of a layer of saltcake (top), a layer of supersaturated liquor (middle), and a layer of soft sludge (bottom), is not corroborated by May, 1997 core sample event. Recent experience indicates that low rotary mode core sample recoveries are not unusual when sampling hard saltcakes. The evidence of liquid in the upper sample tubes may have resulted from intrusion of interstitial liquids or supernatants. There is no corroborating evidence of a liquid layer in tank 241-BX-110.

The analytical data from this sampling event are presented in Horton (1979), and are summarized in Tables B2-52 and B2-53. The sludge sample was yellowish to a dull gray in color, with a consistency like soft putty. A small number of large, water-soluble red crystals found on top of the sludge sample were analyzed separately. Bratzel (1980) provides an assessment of the analytical results in Horton (1979). Specific information is not available concerning sample handling, chain-of-custody, instrument calibration, analytical standards, and procedures used. Consequently, these data should be used with caution.

B2.4.4 Description of the 1975 Grab Sampling Event

A supernatant sample was obtained from tank 241-BX-110 in 1975 to perform actinide analyses (Buckingham 1975). Other chemical and radiological analytes were reported as well. The data are not used in this report because the sample was obtained before the supernatant was removed, and the results do not represent the current waste. For additional information about the results, refer to Brevick et al. (1997).

B2.4.5 Description of the 1976 Grab Sampling Event

A supernatant sample was obtained from tank 241-BX-110 in 1976. A number of chemical, radiological, and physical data were reported (ARHCO 1976). The data are not used in this report because the sample was obtained before the supernatant was pumped out in 1977, and the results do not represent the current waste. For additional information about the results, refer to Brevick et al. (1997).

B2.5 ANALYTICAL RESULTS SUMMARY TABLES FOR THE 1997 PUSH MODE CORE SAMPLES

Table B2-10. Tank 241-BX-110 Analytical Results: Aluminum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	12,900	14,000	13,500
S97T001281	197:2	Lower half	9,320	9,460	9,390
S97T001282	197:2A	Lower half	1,610	1,830	1,720
S97T001308	198:2	Upper half	27,700	28,500	28,100
S97T001307		Lower half	16,900	15,000	16,000
S97T001309	198:3	Lower half	30,500	30,500	30,500
S97T001328	198:4	Lower half	60,300	71,100	65,700
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	6,680	6,670	6,680
S97T001418		Drainable liquid, upper half	3,210	3,200	3,210
S97T001278	197:2	Drainable liquid	5,030	4,920	4,980
S97T001279	197:2A	Drainable liquid	4,950	5,200	5,080
S97T001322	198:1	Drainable liquid	3,430	3,450	3,440
S97T001323	198:2	Drainable liquid	3,910	3,610	3,760
S97T001324	198:3	Drainable liquid	3,610	3,670	3,640

Table B2-11. Tank 241-BX-110 Analytical Results: Antimony (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S97T001280	197:1	Lower half	<1,260	<1,280	<1,270
S97T001281	197:2	Lower half	<1,250	<1,280	<1,270
S97T001282	197:2A	Lower half	2,040	1,370	1,710[QC:e]
S97T001308	198:2	Upper half	<1,270	2,220	<1,750[QC:e]
S97T001307		Lower half	<1,310	1,550	<1,430
S97T001309	198:3	Lower half	<1,260	<1,270	<1,270
S97T001328	198:4	Lower half	1,500	<1,260	<1,380
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	<36.1	<36.1	<36.1
S97T001418		Drainable liquid, upper half	<24.1	<24.1	<24.1
S97T001278	197:2	Drainable liquid	<36.1	<36.1	<36.1
S97T001279	197:2A	Drainable liquid	<36.1	<36.1	<36.1
S97T001322	198:1	Drainable liquid	<36.1	<36.1	<36.1
S97T001323	198:2	Drainable liquid	<24.1	<24.1	<24.1
S97T001324	198:3	Drainable liquid	<24.1	<24.1	<24.1

Table B2-12. Tank 241-BX-110 Analytical Results: Bismuth (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	<2,110	<2,140	<2,130
S97T001281	197:2	Lower half	<2,090	<2,140	<2,120
S97T001282	197:2A	Lower half	<2,110	<2,170	<2,140
S97T001308	198:2	Upper half	7,310	7,650	7,480
S97T001307		Lower half	2,830	2,790	2,810
S97T001309	198:3	Lower half	3,110	3,180	3,150
S97T001328	198:4	Lower half	10,200	9,060	9,630
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	1,040	997	1,020
S97T001418		Drainable liquid, upper half	<40.1	<40.1	<40.1
S97T001278	197:2	Drainable liquid	<60.1	<60.1	<60.1
S97T001279	197:2A	Drainable liquid	<60.1	<60.1	<60.1
S97T001322	198:1	Drainable liquid	<60.1	<60.1	<60.1
S97T001323	198:2	Drainable liquid	43.4	48.6	46
S97T001324	198:3	Drainable liquid	46.6	46.9	46.8

Table B2-13. Tank 241-BX-110 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S97T001280	197:1	Lower half	<1,050	<1,070	<1,060
S97T001281	197:2	Lower half	<1,040	<1,070	<1,060
S97T001282	197:2A	Lower half	<1,050	<1,080	<1,070
S97T001308	198:2	Upper half	<1,060	<1,060	<1,060
S97T001307		Lower half	<1,090	<1,070	<1,080
S97T001309	198:3	Lower half	<1,050	<1,060	<1,060
S97T001328	198:4	Lower half	<1,100	<1,050	<1,080
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S97T001277	197:1	Drainable liquid, lower half	<30.1	31.2	<30.6
S97T001418		Drainable liquid, upper half	23.4	26.1	24.8
S97T001278	197:2	Drainable liquid	38	38.8	38.4
S97T001279	197:2A	Drainable liquid	37.7	39.7	38.7
S97T001322	198:1	Drainable liquid	30.4	<30.1	<30.3
S97T001323	198:2	Drainable liquid	28.2	28	28.1
S97T001324	198:3	Drainable liquid	29.9	30.7	30.3

Table B2-14. Tank 241-BX-110 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S97T001280	197:1	Lower half	<105	148	<127[QC:e]
S97T001281	197:2	Lower half	<104	<107	<106
S97T001282	197:2A	Lower half	<105	<108	<107
S97T001308	198:2	Upper half	<106	<106	<106
S97T001307		Lower half	<109	<107	<108
S97T001309	198:3	Lower half	<105	<106	<106
S97T001328	198:4	Lower half	<110	<105	<108
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	60.7	60.6	60.7
S97T001418		Drainable liquid, upper half	<2	<2	<2
S97T001278	197:2	Drainable liquid	<3	<3	<3
S97T001279	197:2A	Drainable liquid	<3	<3	<3
S97T001322	198:1	Drainable liquid	<3	<3	<3
S97T001323	198:2	Drainable liquid	<2	<2	<2
S97T001324	198:3	Drainable liquid	<2	<2	<2

Table B2-15. Tank 241-BX-110 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	<2,110	<2,140	<2,130
S97T001281	197:2	Lower half	<2,090	<2,140	<2,120
S97T001282	197:2A	Lower half	<2,110	<2,170	<2,140
S97T001308	198:2	Upper half	<2,120	<2,110	<2,120
S97T001307		Lower half	<2,180	<2,140	<2,160
S97T001309	198:3	Lower half	<2,100	<2,120	<2,110
S97T001328	198:4	Lower half	<2,200	<2,100	<2,150
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	145	149	147
S97T001418		Drainable liquid, upper half	<40.1	<40.1	<40.1
S97T001278	197:2	Drainable liquid	<60.1	<60.1	<60.1
S97T001279	197:2A	Drainable liquid	<60.1	<60.1	<60.1
S97T001322	198:1	Drainable liquid	<60.1	<60.1	<60.1
S97T001323	198:2	Drainable liquid	<40.1	<40.1	<40.1
S97T001324	198:3	Drainable liquid	<40.1	<40.1	<40.1

Table B2-16. Tank 241-BX-110 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	22,200	23,300	22,800
S97T001281	197:2	Lower half	7,050	6,930	6,990
S97T001282	197:2A	Lower half	767	842	805
S97T001308	198:2	Upper half	5,230	5,270	5,250
S97T001307		Lower half	2,310	2,070	2,190
S97T001309	198:3	Lower half	1,900	1,950	1,930
S97T001328	198:4	Lower half	1,200	1,200	1,200
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	13,800	13,800	13,800
S97T001418		Drainable liquid, upper half	1,040	1,040	1,040
S97T001278	197:2	Drainable liquid	1,630	1,690	1,660
S97T001279	197:2A	Drainable liquid	1,540	1,630	1,590
S97T001322	198:1	Drainable liquid	1,210	1,220	1,220
S97T001323	198:2	Drainable liquid	1,280	1,180	1,230
S97T001324	198:3	Drainable liquid	1,050	1,080	1,070

Table B2-17. Tank 241-BX-110 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S97T001280	197:1	Lower half	<1,050	<1,070	<1,060
S97T001281	197:2	Lower half	<1,040	<1,070	<1,060
S97T001282	197:2A	Lower half	<1,050	<1,080	<1,070
S97T001308	198:2	Upper half	7,610	3,760	5,690[QC:e]
S97T001307		Lower half	1,560	1,210	1,390[QC:e]
S97T001309	198:3	Lower half	1,790	1,520	1,660
S97T001328	198:4	Lower half	4,170	4,180	4,180
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S97T001277	197:1	Drainable liquid, lower half	109	109	109
S97T001418		Drainable liquid, upper half	<20.1	<20.1	<20.1
S97T001278	197:2	Drainable liquid	<30.1	<30.1	<30.1
S97T001279	197:2A	Drainable liquid	<30.1	<30.1	<30.1
S97T001322	198:1	Drainable liquid	<30.1	<30.1	<30.1
S97T001323	198:2	Drainable liquid	<20.1	<20.1	<20.1
S97T001324	198:3	Drainable liquid	<20.1	<20.1	<20.1

Table B2-18. Tank 241-BX-110 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S97T001280	197:1	Lower half	<2,110	<2,140	<2,130
S97T001281	197:2	Lower half	<2,090	<2,140	<2,120
S97T001282	197:2A	Lower half	<2,110	<2,170	<2,140
S97T001308	198:2	Upper half	<2,120	<2,110	<2,120
S97T001307		Lower half	<2,180	<2,140	<2,160
S97T001309	198:3	Lower half	<2,100	<2,120	<2,110
S97T001328	198:4	Lower half	<2,200	<2,100	<2,150
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	475	479	477
S97T001418		Drainable liquid, upper half	<40.1	<40.1	<40.1
S97T001278	197:2	Drainable liquid	<60.1	<60.1	<60.1
S97T001279	197:2A	Drainable liquid	<60.1	<60.1	<60.1
S97T001322	198:1	Drainable liquid	<60.1	<60.1	<60.1
S97T001323	198:2	Drainable liquid	<40.1	<40.1	<40.1
S97T001324	198:3	Drainable liquid	<40.1	<40.1	<40.1

Table B2-19. Tank 241-BX-110 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	<1,050	<1,070	<1,060
S97T001281	197:2	Lower half	<1,040	<1,070	<1,060
S97T001282	197:2A	Lower half	<1,050	<1,080	<1,070
S97T001308	198:2	Upper half	<1,060	<1,060	<1,060
S97T001307		Lower half	<1,090	<1,070	<1,080
S97T001309	198:3	Lower half	<1,050	<1,060	<1,060
S97T001328	198:4	Lower half	<1,100	<1,050	<1,080
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	<30.1	<30.1	<30.1
S97T001418		Drainable liquid, upper half	21.2	21.4	21.3
S97T001278	197:2	Drainable liquid	32.6	32	32.3
S97T001279	197:2A	Drainable liquid	33.8	34.8	34.3
S97T001322	198:1	Drainable liquid	<30.1	<30.1	<30.1
S97T001323	198:2	Drainable liquid	26.4	25.5	25.9
S97T001324	198:3	Drainable liquid	27.8	27.1	27.5

Table B2-20. Tank 241-BX-110 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid	78.1	79.4	78.8
S97T001418		Drainable liquid	<8.02	<8.02	<8.02
S97T001278	197:2	Drainable liquid	<12	<12	<12
S97T001279	197:2A	Drainable liquid	<12	<12	<12
S97T001322	198:1	Drainable liquid	<12	<12	<12
S97T001323	198:2	Drainable liquid	<8.02	<8.02	<8.02
S97T001324	198:3	Drainable liquid	<8.02	<8.02	<8.02

Table B2-21. Tank 241-BX-110 Analytical Results: Phosphorus (ICP):

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	15,500	15,000	15,300
S97T001281	197:2	Lower half	16,000	18,200	17,100
S97T001282	197:2A	Lower half	8,340	5,060	6,700[QC:e]
S97T001308	198:2	Upper half	25,700	28,100	26,900
S97T001307		Lower half	19,400	22,000	20,700
S97T001309	198:3	Lower half	11,400	15,100	13,300[QC:e]
S97T001328	198:4	Lower half	10,600	28,300	19,500[QC:e]
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	475	464	470
S97T001418		Drainable liquid, upper half	468	466	467
S97T001278	197:2	Drainable liquid	741	719	730
S97T001279	197:2A	Drainable liquid	621	651	636
S97T001322	198:1	Drainable liquid	515	512	514
S97T001323	198:2	Drainable liquid	543	496	520
S97T001324	198:3	Drainable liquid	484	482	483

Table B2-22. Tank 241-BX-110 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	2,580	2,530	2,560
S97T001418		Drainable liquid, upper half	2,530	2,450	2,490
S97T001278	197:2	Drainable liquid	3,920	3,720	3,820
S97T001279	197:2A	Drainable liquid	3,720	3,930	3,830
S97T001322	198:1	Drainable liquid	2,890	2,750	2,820
S97T001323	198:2	Drainable liquid	3,030	2,770	2,900
S97T001324	198:3	Drainable liquid	2,830	2,820	2,830

Table B2-23. Tank 241-BX-110 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	<1,050	<1,070	<1,060
S97T001281	197:2	Lower half	<1,040	<1,070	<1,060
S97T001282	197:2A	Lower half	<1,050	<1,080	<1,070
S97T001308	198:2	Upper half	2,150	2,390	2,270
S97T001307		Lower half	1,300	1,670	1,490[QC:e]
S97T001309	198:3	Lower half	1,380	1,340	1,360
S97T001328	198:4	Lower half	3,010	3,060	3,040
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	153	152	153
S97T001418		Drainable liquid, upper half	108	102	105
S97T001278	197:2	Drainable liquid	110	106	108
S97T001279	197:2A	Drainable liquid	126	137	132
S97T001322	198:1	Drainable liquid	50.2	51.1	50.7
S97T001323	198:2	Drainable liquid	110	85.9	98[QC:e]
S97T001324	198:3	Drainable liquid	112	122	117

Table B2-24. Tank 241-BX-110 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	<211	<214	<213[QC:c]
S97T001281	197:2	Lower half	<209	<214	<212
S97T001282	197:2A	Lower half	<211	<217	<214
S97T001308	198:2	Upper half	<212	<211	<212
S97T001307		Lower half	<218	<214	<216
S97T001309	198:3	Lower half	<210	<212	<211
S97T001328	198:4	Lower half	<220	<210	<215
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	14.5	14	14.3
S97T001418		Drainable liquid, upper half	13.2	12.9	13.1
S97T001278	197:2	Drainable liquid	20.2	19.9	20
S97T001279	197:2A	Drainable liquid	18.9	20.4	19.6
S97T001322	198:1	Drainable liquid	15.4	15.2	15.3
S97T001323	198:2	Drainable liquid, upper half	16.1	15.1	15.6
S97T001324	198:3	Drainable liquid	14.3	14.4	14.4

Table B2-25. Tank 241-BX-110 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	1.75E+05	1.75E+05	1.75E+05
S97T001281	197:2	Lower half	2.37E+05	2.37E+05	2.37E+05
S97T001282	197:2A	Lower half	2.66E+05	2.66E+05	2.66E+05
S97T001308	198:2	Upper half	2.17E+05	2.19E+05	2.18E+05
S97T001307		Lower half	2.71E+05	2.71E+05	2.71E+05
S97T001309	198:3	Lower half	2.57E+05	2.45E+05	2.51E+05
S97T001328	198:4	Lower half	2.26E+05	2.05E+05	2.16E+05
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	1.99E+05	1.96E+05	1.98E+05
S97T001418		Drainable liquid, upper half	1.83E+05	1.83E+05	1.83E+05
S97T001278	197:2	Drainable liquid	2.88E+05	2.81E+05	2.85E+05
S97T001279	197:2A	Drainable liquid	2.75E+05	2.88E+05	2.82E+05
S97T001322	198:1	Drainable liquid	2.09E+05	2.09E+05	2.09E+05[QC:c]
S97T001323	198:2	Drainable liquid	2.18E+05	2.01E+05	2.10E+05
S97T001324	198:3	Drainable liquid	1.96E+05	1.98E+05	1.97E+05

Table B2-26. Tank 241-BX-110 Analytical Results: Strontium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	<211	<214	<213
S97T001281	197:2	Lower half	<209	<214	<212
S97T001282	197:2A	Lower half	<211	<217	<214
S97T001308	198:2	Upper half	<212	<211	<212
S97T001307		Lower half	<218	<214	<216
S97T001309	198:3	Lower half	<210	<212	<211
S97T001328	198:4	Lower half	<220	<210	<215
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	7.89	7.94	7.92
S97T001418		Drainable liquid, upper half	<4.01	<4.01	<4.01
S97T001278	197:2	Drainable liquid	<6.01	<6.01	<6.01
S97T001279	197:2A	Drainable liquid	<6.01	<6.01	<6.01
S97T001322	198:1	Drainable liquid	<6.01	<6.01	<6.01
S97T001323	198:2	Drainable liquid	<4.01	<4.01	<4.01
S97T001324	198:3	Drainable liquid	<4.01	<4.01	<4.01

Table B2-27. Tank 241-BX-110 Analytical Results: Sulfur (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	<2,110	<2,140	<2,130
S97T001281	197:2	Lower half	<2,090	<2,140	<2,120
S97T001282	197:2A	Lower half	<2,110	<2,170	<2,140
S97T001308	198:2	Upper half	6,350	6,500	6,430
S97T001307		Lower half	2,360	2,500	2,430
S97T001309	198:3	Lower half	3,160	3,210	3,190
S97T001328	198:4	Lower half	4,590	4,900	4,750
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	1,720	1,700	1,710
S97T001418		Drainable liquid, upper half	1,640	1,630	1,640
S97T001278	197:2	Drainable liquid	2,550	2,480	2,520
S97T001279	197:2A	Drainable liquid	2,480	2,620	2,550
S97T001322	198:1	Drainable liquid	1,820	1,840	1,830
S97T001323	198:2	Drainable liquid	1,800	1,670	1,740
S97T001324	198:3	Drainable liquid	1,620	1,640	1,630

Table B2-28. Tank 241-BX-110 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
S97T001280	197:1	Lower half	<211	<214	<213
S97T001281	197:2	Lower half	<209	<214	<212
S97T001282	197:2A	Lower half	<211	<217	<214
S97T001308	198:2	Upper half	<212	<211	<212
S97T001307		Lower half	<218	<214	<216
S97T001309	198:3	Lower half	<210	<212	<211
S97T001328	198:4	Lower half	<220	<210	<215
Liquids			**μg/mL**	**μg/mL**	**μg/mL**
S97T001277	197:1	Drainable liquid, lower half	44.1	44.7	44.4
S97T001418		Drainable liquid, upper half	4.97	4.75	4.86
S97T001278	197:2	Drainable liquid	<6.01	<6.01	<6.01
S97T001279	197:2A	Drainable liquid	6.87	7.57	7.22
S97T001322	198:1	Drainable liquid	<6.01	<6.01	<6.01
S97T001323	198:2	Drainable liquid	6.33	5.92	6.13
S97T001324	198:3	Drainable liquid	4.78	5.87	5.33[QC:e]

Table B2-29. Tank 241-BX-110 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S97T001280	197:1	Lower half	<211	<214	<213
S97T001281	197:2	Lower half	<209	<214	<212
S97T001282	197:2A	Lower half	<211	<217	<214
S97T001308	198:2	Upper half	<212	<211	<212
S97T001307		Lower half	<218	<214	<216
S97T001309	198:3	Lower half	<210	<212	<211
S97T001328	198:4	Lower half	<220	<210	<215
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	9.22	9.68	9.45
S97T001418		Drainable liquid, upper half	<4.01	<4.01	<4.01
S97T001278	197:2	Drainable liquid	<6.01	<6.01	<6.01
S97T001279	197:2A	Drainable liquid	<6.01	<6.01	<6.01
S97T001322	198:1	Drainable liquid	<6.01	<6.01	<6.01
S97T001323	198:2	Drainable liquid	<4.01	<4.01	<4.01
S97T001324	198:3	Drainable liquid	<4.01	<4.01	<4.01

Table B2-30. Tank 241-BX-110 Analytical Results: Non-Detected Inductively Coupled Plasma Spectroscopy and Ion Chromatography Analytes.

Analyte	Detection Limit Range - Solids (μg/g)	Detection Limit Range - Liquids (μg/g)
Arsenic	<2,100 - <2200 (ICP fusion)	<40.1 - <60.1 (ICP acid)
Barium	<1,040 - <1100 (ICP fusion)	<20.1 - <30.1 (ICP acid)
Beryllium	<104 - <110 (ICP fusion)	<2 - <3 (ICP acid)
Bromide	<957 - <1100 (IC water)	<1020 - <5060 (IC water)
Cerium	<2,090 - <2200 (ICP fusion)	<40.1 - <60.1 (ICP acid)
Cobalt	<418 - <440 (ICP fusion)	<8.02 - <12 (ICP acid)
Copper	<209 - <220 (ICP fusion)	<4.01 - <6.01 (ICP acid)
Lanthanum	<1,040 - <1100 (ICP fusion)	<20.1 - <30.1 (ICP acid)
Lithium	<209 - <220 (ICP fusion)	<4.01 - <6.01 (ICP acid)
Magnesium	<2,090 - <2200 (ICP fusion)	<40.1 - <60.1 (ICP acid)
Manganese	<209 - <220 (ICP fusion)	<4.01 - <6.01 (ICP acid)
Neodymium	<2,090 - <2200 (ICP fusion)	<40.1 - <60.1 (ICP acid)
Samarium	<2,090 - <2200 (ICP fusion)	<40.1 - <60.1 (ICP acid)
Selenium	n/r	<40.1 - <60.1 (ICP acid)
Thallium	<4,180 - <4400 (ICP fusion)	<80.2 - <120 (ICP acid)
Titanium	<209 - <220 (ICP fusion)	<4.01 - <6.01 (ICP acid)
Uranium	<10,400 - <11,000 (ICP fusion)	<200 - <300 (ICP acid)
Vanadium	<1,040 - <1100 (ICP fusion)	<20.1 - <30.1 (ICP acid)

Note:

n/r = not reported

Table B2-31. Tank 241-BX-110 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
S97T001283	197:1	Lower half	2,280	2,150	2,210
S97T001284	197:2	Lower half	1,350	1,570	1,460
S97T001285	197:2A	Lower half	953	911	932
S97T001311	198:2	Upper half	1,260	1,280	1,270
S97T001310		Lower half	964	1,290	1,130[QC:e]
S97T001312	198:3	Lower half	1,030	1,140	1,090
S97T001329	198:4	Lower half	1,060	1,460	1,260[QC:e]
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	3,700	3,770	3,730
S97T001418		Drainable liquid, upper half	3,920	3,960	3,940
S97T001278	197:2	Drainable liquid	3,860	3,860	3,860
S97T001279	197:2A	Drainable liquid	4,320	4,100	4,210
S97T001322	198:1	Drainable liquid	13,200	13,300	13,300
S97T001323	198:2	Drainable liquid	4,460	4,390	4,430
S97T001324	198:3	Drainable liquid	4,820	4,870	4,850

Table B2-32. Tank 241-BX-110 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
S97T001283	197:1	Lower half	3,390	5,910	4,650[QC:d,e]
S97T001284	197:2	Lower half	4,110	4,590	4,350
S97T001285	197:2A	Lower half	777	879	828
S97T001311	198:2	Upper half	11,300	10,600	11,000
S97T001310		Lower half	6,550	7,310	6,930
S97T001312	198:3	Lower half	4,610	5,370	4,990
S97T001329	198:4	Lower half	12,700	8,830	10,800[QC:e]
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	1,240	903	1,070[QC:e]
S97T001418		Drainable liquid, upper half	1,150	1,300	1,230
S97T001278	197:2	Drainable liquid	699	1,390	1,040[QC:e]
S97T001279	197:2A	Drainable liquid	945	1,480	1,210[QC:c,e]
S97T001322	198:1	Drainable liquid	2,920	4,030	3,480[QC:e]
S97T001323	198:2	Drainable liquid	802	845	824
S97T001324	198:3	Drainable liquid	801	836	819

Table B2-33. Tank 241-BX-110 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
S97T001283	197:1	Lower half	2.39E+05	2.20E+05	2.30E+05
S97T001284	197:2	Lower half	4.22E+05	4.29E+05	4.25E+05
S97T001285	197:2A	Lower half	6.22E+05	6.15E+05	6.18E+05
S97T001311	198:2	Upper half	2.29E+05	2.22E+05	2.25E+05
S97T001310		Lower half	4.78E+05	4.59E+05	4.69E+05
S97T001312	198:3	Lower half	4.74E+05	4.43E+05	4.59E+05
S97T001329	198:4	Lower half	2.35E+05	2.80E+05	2.58E+05
Liquids			μg/mL	μg/mL	μg/mL
S97T001277	197:1	Drainable liquid, lower half	3.93E+05	3.92E+05	3.92E+05
S97T001418		Drainable liquid, upper half	3.97E+05	3.97E+05	3.97E+05
S97T001278	197:2	Drainable liquid	4.04E+05	4.01E+05	4.02E+05
S97T001279	197:2A	Drainable liquid	4.04E+05	4.01E+05	4.03E+05
S97T001322	198:1	Drainable liquid	1.45E+06	1.46E+06	1.45E+06[QC:c]
S97T001323	198:2	Drainable liquid	4.45E+05	4.40E+05	4.42E+05
S97T001324	198:3	Drainable liquid	4.37E+05	4.38E+05	4.38E+05

Table B2-34. Tank 241-BX-110 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S97T001283	197:1	Lower half	18,100	17,400	17,700
S97T001284	197:2	Lower half	10,600	10,200	10,400
S97T001285	197:2A	Lower half	7,300	6,750	7,030
S97T001311	198:2	Upper half	10,600	10,400	10,500
S97T001310		Lower half	7,420	9,020	8,220
S97T001312	198:3	Lower half	8,160	9,740	8,950
S97T001329	198:4	Lower half	7,960	10,900	9,430[QC:e]
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	35,400	34,800	35,100
S97T001418		Drainable liquid, upper half	35,700	35,700	35,700
S97T001278	197:2	Drainable liquid	36,300	36,200	36,200
S97T001279	197:2A	Drainable liquid	37,300	36,900	37,100
S97T001322	198:1	Drainable liquid	131,000	129,000	130,000
S97T001323	198:2	Drainable liquid	43,200	43,200	43,200
S97T001324	198:3	Drainable liquid	47,300	47,500	47,400

Table B2-35. Tank 241-BX-110 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001283	197:1	Lower half	39,500	50,200	44,900[QC:e]
S97T001284	197:2	Lower half	37,400	39,500	38,400
S97T001285	197:2A	Lower half	11,000	13,300	12,200
S97T001311	198:2	Upper half	70,000	63,100	66,600
S97T001310		Lower half	52,900	54,800	53,900
S97T001312	198:3	Lower half	32,600	33,400	33,000
S97T001329	198:4	Lower half	93,700	42,300	68,000[QC:e]
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S97T001277	197:1	Drainable liquid, lower half	1,470	1,330	1,400
S97T001418		Drainable liquid, upper half	1,550	1,570	1,560
S97T001278	197:2	Drainable liquid	1,350	1,590	1,470
S97T001279	197:2A	Drainable liquid	1,350	<1,220	<1,290
S97T001322	198:1	Drainable liquid	5,460	5,850	5,660
S97T001323	198:2	Drainable liquid	1,390	1,040	1,220[QC:e]
S97T001324	198:3	Drainable liquid	1,620	1,250	1,440[QC:e]

Table B2-36. Tank 241-BX-110 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S97T001283	197:1	Lower half	3,130	3,170	3,150
S97T001284	197:2	Lower half	2,890	2,040	2,470[QC:e]
S97T001285	197:2A	Lower half	1,830	1,850	1,840
S97T001311	198:2	Upper half	15,900	15,800	15,900
S97T001310		Lower half	6,380	7,560	6,970
S97T001312	198:3	Lower half	6,680	9,190	7,930[QC:e]
S97T001329	198:4	Lower half	10,400	14,900	12,600[QC:e]
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	2,570	2,340	2,460
S97T001418		Drainable liquid, upper half	2,390	2,260	2,330
S97T001278	197:2	Drainable liquid	2,330	2,200	2,270
S97T001279	197:2A	Drainable liquid	2,210	2,050	2,130
S97T001322	198:1	Drainable liquid	12,100	16,000	14,100[QC:e]
S97T001323	198:2	Drainable liquid	3,020	2,990	3,010
S97T001324	198:3	Drainable liquid	2,630	2,920	2,770

Table B2-37. Tank 241-BX-110 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S97T001283	197:1	Lower half	7,240	6,700	6,970
S97T001284	197:2	Lower half	3,760	4,240	4,000
S97T001285	197:2A	Lower half	<910	<899	<904
S97T001311	198:2	Upper half	8,930	8,800	8,860
S97T001310		Lower half	3,400	4,460	3,930[QC:e]
S97T001312	198:3	Lower half	1,750	2,200	1,980[QC:e]
S97T001329	198:4	Lower half	<823	<804	<813
Liquids			µg/mL	µg/mL	µg/mL
S97T001277	197:1	Drainable liquid, lower half	3,500	5,220	4,360[QC:e]
S97T001418		Drainable liquid, upper half	<1,070	<1,070	<1,070
S97T001278	197:2	Drainable liquid	<1,070	<1,070	<1,070
S97T001279	197:2A	Drainable liquid	<1,070	<1,070	<1,070
S97T001322	198:1	Drainable liquid	<4250	<4250	<4250
S97T001323	198:2	Drainable liquid	994	1,140	1,070
S97T001324	198:3	Drainable liquid	<859	985	<922

Table B2-38. Tank 241-BX-110 Analytical Results: Density (Gravimetric).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: bulk density			g/mL	g/mL	g/mL
S97T001260	197:1	Lower half	1.54	n/a	1.54
S97T001263	197:2	Lower half	1.78	n/a	1.78
S97T001264	197:2A	Lower half	1.89	n/a	1.89
S97T001299	198:2	Upper half	1.72	n/a	1.72
S97T001298		Lower half	1.83	n/a	1.83
S97T001300	198:3	Lower half	1.88	n/a	1.88
S97T001325	198:4	Lower half	1.87	n/a	1.87
Liquids: specific gravity			unitless	unitless	unitless
S97T001277	197:1	Drainable liquid	1.53	1.58	1.56
S97T001278	197:2	Drainable liquid	1.67	1.61	1.64
S97T001279	197:2A	Drainable liquid	1.51	1.48	1.49
S97T001322	198:1	Drainable liquid	1.37	1.36	1.36
S97T001323	198:2	Drainable liquid	1.38	1.37	1.37
S97T001324	198:3	Drainable liquid	1.42	1.43	1.42

Table B2-39. Tank 241-BX-110 Analytical Results: Exotherm - Transition 1 (DSC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			J/g (dry weight)	J/g (dry weight)	J/g (dry weight)
S97T001262	197:1	Lower half	0	0	0
S97T001269	197:2	Lower half	0	0	0
S97T001270	197:2A	Lower half	0	0	0
S97T001305	198:2	Upper half	0	0	0
S97T001304		Lower half	0	0	0
S97T001306	198:3	Lower half	0	0	0
S97T001326	198:4	Lower half	0	0	0
Liquids			J/g (dry weight)	J/g (dry weight)	J/g (dry weight)
S97T001277	197:1	Drainable liquid, lower half	0	0	0
S97T001418		Drainable liquid, upper half	0	0	0
S97T001278	197:2	Drainable liquid	0	0	0
S97T001279	197:2A	Drainable liquid	0	0	0
S97T001322	198:1	Drainable liquid	0	0	0
S97T001323	198:2	Drainable liquid	0	0	0
S97T001324	198:3	Drainable liquid	0	0	0

Table B2-40. Tank 241-BX-110 Analytical Results: Percent Water (DSC/TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
S97T001262	197:1	Lower half	48.1	48.5	48.3
S97T001269	197:2	Lower half	46.5	47	46.8
S97T001270	197:2A	Lower half	11.8	15	13.4
S97T001305	198:2	Upper half	39.9	42.9	41.4
S97T001304		Lower half	25.1	29.6	27.3
S97T001306	198:3	Lower half	31.5	36.5	34
S97T001326	198:4	Lower half	44.6	40.2	42.4
Liquids			%	%	%
S97T001277	197:1	Drainable liquid, lower half	52.1	51.8	52
S97T001418		Drainable liquid, upper half	53.2	53.1	53.2
S97T001278	197:2	Drainable liquid	53.1	53.1	53.1
S97T001279	197:2A	Drainable liquid	53.1	52.8	53
S97T001322	198:1	Drainable liquid	53.9	54	53.9
S97T001323	198:2	Drainable liquid	52.5	53	52.8
S97T001324	198:3	Drainable liquid	53.9	54.2	54.1

Table B2-41. Tank 241-BX-110 Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S97T001280	197:1	Lower half	0.00555	0.00399	0.00477[QC:c,e]
S97T001281	197:2	Lower half	<0.00318	<0.00263	<0.00291
S97T001282	197:2A	Lower half	<0.00172	<0.00177	<0.00175
S97T001307	198:2	Lower half	0.0107	0.00922	0.00996[QC:f]
S97T001309	198:3	Lower half	0.0105	0.0126	0.0116[QC:f]
S97T001328	198:4	Lower half	0.0234	0.0202	0.0218[QC:c]
Liquids			μCi/mL	μCi/mL	μCi/mL
S97T001277	197:1	Drainable liquid	<0.00444	<0.0083	<0.00637[QC:e]
S97T001278	197:2	Drainable liquid	<0.0083	0.00501	<0.00666[QC:e]
S97T001279	197:2A	Drainable liquid	<0.00526	<0.0083	<0.00678[QC:e]
S97T001322	198:1	Drainable liquid	<0.00395	<0.00325	<0.0036
S97T001323	198:2	Drainable liquid	<0.00465	<0.00465	<0.00465
S97T001324	198:3	Drainable liquid	<0.00325	<0.00672	<0.00499[QC:e]

Table B2-42. Tank 241-BX-110 Analytical Results: Total Inorganic Carbon (TIC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Triplicate	Mean
Solids			µg/g	µg/g	µg/g	µg/g
S97T001262	197:1	Lower half	1,830	1,690		1,760
S97T001269	197:2	Lower half	1,090	950		1,020
S97T001270	197:2A	Lower half	928	939		934
S97T001305	198:2	Upper half	1,150	1,240	636	1,010
S97T001304		Lower half	890	843	888	874
S97T001306	198:3	Lower half	647	578	568	598
S97T001326	198:4	Lower half	401	506		454[QC:e]

Table B2-43. Tank 241-BX-110 Analytical Results: Total Organic Carbon (TOC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Triplicate	Mean
Solids			µg/g	µg/g	µg/g	µg/g
S97T001262	197:1	Lower half	2,880	2,650		2,770
S97T001269	197:2	Lower half	1,930	1,610		1,770
S97T001270	197:2A	Lower half	1,060	964		1,010
S97T001305	198:2	Upper half	1,210	3,160	2,270	2,210[QC:e]
S97T001304		Lower half	628	1,320	1,340	1,100[QC:e]
S97T001306	198:3	Lower half	466	790	514	590[QC:e]
S97T001326	198:4	Lower half	287	365		326[QC:e]

B2.6 ANALYTICAL RESULTS SUMMARY TABLES FOR THE 1996 VAPOR SAMPLES

Table B2-44. Tank 241-BX-111 Vapor Analysis Results.[1]

Analyte of Interest	Sample Medium	Concentration
NH_3	Sorbent traps	63 ppmv
NO_2	Sorbent traps	≤0.15 ppmv
NO	Sorbent traps	≤0.15 ppmv
Gravimetric (primarily water)	Sorbent traps	8.9 mg/L
CO_2	SUMMA™ canister	<17 ppmv
CO	SUMMA™ canister	<17 ppmv
CH_4	SUMMA™ canister	<25 ppmv
H_2	SUMMA™ canister	<17 ppmv
N_2O	SUMMA™ canister	<17 ppmv
Total nonmethane hydrocarbons	SUMMA™ canister	1.9 mg/m^3
Methanol	SUMMA™ canister	957 ppbv
Ethanol	SUMMA™ canister	745 ppbv
Acetone	SUMMA™ canister	188 ppbv
1-Butanol	SUMMA™ canister	30.6 ppbv
2-Butanone	SUMMA™ canister	7.4 ppbv
Methanol	Sorbent traps	294 ppbv
Ethanol	Sorbent traps	270 ppbv
Acetone	Sorbent traps	130 ppbv
1-Butanol	Sorbent traps	25 ppbv
Acetonitrile	Sorbent traps	12 ppbv
Tetradecane	Sorbent traps	11 ppbv
Propanol	Sorbent traps	11 ppbv
Pyridine	Sorbent traps	10 ppbv

Note:

[1]Evans et al. (1997)

B2.7 ANALYTICAL RESULTS SUMMARY TABLES FOR THE 1995 AUGER SAMPLES

Table B2-45. Tank 241-BX-110 Total Alpha Activity Results.[1]

Sample Number	Sample Location	Result	Duplicate	Mean	Overall Mean
		µCi/g	µCi/g	µCi/g	µCi/g
S95T002906	Riser 6	<0.00261	<0.00165	<0.00213[QC:a,c]	0.00652
S95T002946	Riser 3	0.0101	0.0118	0.0109[QC:c]	

Notes:
[1]Hardy (1998)

Table B2-46. Tank 241-BX-110 Total Organic Carbon Results.[1]

Sample Number	Result	Duplicate	Mean	Overall Mean	RSD (Mean)
	µg	µg	µg	µg	%
S95T002903	3,480	3,470	3,480	3,740	7
S95T002945	4,100	3,890	4,000		

Note:
[1]Hardy (1998)

Table B2-47. Tank 241-BX-110 Total Inorganic Carbon Results.[1]

Sample Number	Result	Duplicate	Mean	Overall Mean	RSD (Mean)
	µg/g	µg/g	µg/g	µg/g	%
S95T002903	681.0	687.0	684.0	811.3	16
S95T002945	946.0	931.0	938.5		

Note:
[1]Hardy (1998)

Table B2-48. Tank 241-BX-110 1995 Auger Density Results.[1]

Sample Number	Result	Overall Mean
	g/mL	g/mL
S95T002905	1.570	1.635
S95T002948	1.700	

Note:
[1]Hardy (1998)

Table B2-49. Thermogravimetric Analysis Results for Tank 241-BX-110 1995 Augers.[1]

Sample Number	Temp. Range	Result	Duplicate	Mean	Overall Mean	RSD (Mean)
	°C	% Water	% Water	% Water	% Water	%
S95T002903[2]	35-180	45.22	43.67	44.45	37.48	15.5
S95T002945[2]	35-180	31.89 35.68[3]	30.93	32.83		

Notes:
[1]Hardy (1998)
[2]Triplicate run

Table B2-50. Differential Scanning Calorimetry Analysis Results for Tank 241-BX-110 1995 Augers.[1]

Sample Number	Run	Sample Weight (mg)	Transition 1		Transition 2		Transition 3	
			Temp. range (°C)	ΔH (J/g)	Temp. range (°C)	ΔH (J/g)	Temp. range (°C)	ΔH (J/g)
Auger Sample 95-AUG-045								
S95T002903[QC:e]	1	35.56	ambient 180	773.4	210-280	41.2	420-470	-7.6
S95T002903[QC:e]	2	17.34	ambient 190	1394.0	270-300	4.1	---	---
S95T002903[QC:e]	3	31.23	ambient 190	779.2	220-320	79.3	380-460	-24.8
Auger Sample 95-AUG-046								
S95T002945[QC:e]	1	26.59	ambient 170	808.5	190-300	74.2	---	---
S95T002945[QC:e]	2	29.75	ambient 190	695.6	210-320	117.0	390-440	-16.2
S95T002945[QC:e]	3	14.06	ambient 180	986.5	200-310	76.5	400-420	-6.1

Notes:

--- = no transition

ΔH = change in enthalpy (negative sign denotes exothermic reaction)

[1]Hardy (1998)

B2.8 ANALYTICAL RESULTS SUMMARY TABLES FOR HISTORICAL SAMPLES

Tables B2-51 through B2-53 summarize the analytical results for historical samples.

HISTORICAL DATA TABLES

Table B2-51. 1990 Supernatant Sample Analytical Results.[1] (2 sheets)

Physical Properties	
Density	1.37 g/mL
Percent water	56.6 wt%
pH	12.5
Metal	**Concentration (μg/g)**
Al	529
Ca	8.98
Cr	972
K	2,920
Mo	66.9
Na	164,220
P	406
Si	43.8
U	1,020
Anion	**Concentration (μg/g)**
Cl^-	4,900
F^-	<1,410
NO_2^-	36,500
NO_3^-	312,000
SO_4^-	<14,600
OH^-	23,500
CO_3^-	17,200

Table B2-51. 1990 Supernatant Sample Analytical Results.[1] (2 sheets)

Radionuclide	Concentration (μCi/L)
Total alpha	<0.00424
Total beta	167
^{137}Cs (water)	135
^{137}Cs (acid)	131
$^{89/90}$Sr	0.015
$^{239/240}$Pu	<7.99E-5
^{241}Am	<2.60E-4
Total Carbon	**Concentration (μg/g)**
Total organic carbon	4,090

Note:

[1]Weiss (1990)

Table B2-52. 1978 Core Sludge Sample Analytical Results.[1,3]

Physical Properties			
Density	1.45 g/cm^3		
Particle density	1.83 g/cm^3		
Percent water	51.9 wt%		
Appearance	Yellowish to dull gray in color, with consistency like putty		
Ion/Radionuclide	**Water Soluble Concentration (μg/g)**	**Water Insoluble Concentration (μg/g)**	**Combined Concentration (μg/g)**
Al	n/r	18,400	18,400
Bi	< 103	38,400	38,400
Cd	< 336	n/r	< 336
Cr	< 81.8	1,310	1,310
F	1,700	Deleted	1,700
La	n/r	151	151
Na	132,000	n/r	132,000
NO_3^-	140,000	n/r	140,000
PO_4^-	19,300	981 (98,000)[2]	20,281
Si	n/r	1,780	1,780
SO_4^{-}	5,760	< 2,910	5,760
Zr	n/r	< 310	< 310
TOC	169	600	769
U	5.08	42.3	47
Pu	55.7	2.13	58
Radionuclide	**Water Soluble Concentration (μCi/g)**	**Water Insoluble Concentration (μCi/g)**	**Combined Concentration (μCi/g)**
^{137}Cs	11.8	36.5	48.3
$^{89/90}Sr$	5.59E-4	7.79	7.79

Notes:

[1]Bratzel (1980)

[2]Horton (1979) reported a 9.8 percent insoluble PO_4 value, which is more consistent with other analyses.

[3]These data have not been validated and should be used with caution.

Table B2-53. 1978 Core Sample Analytical Results: Red Crystals.[1,2]

Physical Properties	
Density	1.71 g/cm^3
Percent water	30.0 wt%
Water solubility	Complete
Appearance	Large red crystals
Ion/Radionuclide	**Water Soluble Concentration (μg/g)**
Bi	<2,000
CrO_4^-	700
F^-	15,000
Na	206,000
NO_3^-	208,000
OH^-	22,000
PO_4^-	100,000
SiO_2^{2-}	1,000
SO_4^{2-}	13,000
Zr	<300
U	6.48
Pu	0.541
Radionuclide	**Water Soluble Concentration (μCi/g)**
^{137}Cs	47.7
$^{89/90}Sr$	0.028

Note:

[1]Horton (1979). Not included in Bratzel (1980)

[2]These data have not been validated and should be used with caution.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This section discusses the overall quality and consistency of the current sampling results for tank 241-BX-110 and provides the results of an analytical-based inventory calculation.

This section also evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify limitations in data use.

B3.1 FIELD OBSERVATIONS

The behavior of the waste beneath riser 6 differed from that beneath riser 3. The push mode core sampling system was unable to penetrate the saltcake layer beneath riser 6, leaving the postulated sludge layer beneath the saltcake unsampled by core 197. The waste beneath riser 3 was much more yielding, and was readily sampled by core 198. These differences are reflected in the physical appearance of the sample material, and reflect differences noted during the 1995 auger sampling. Core 197 yielded grayish blue, granular salt, as did auger sample 95-AUG-045 from the same riser in 1995. While no solids were recovered from segment 1 of core 198, the 1995 auger sample from the same location beneath riser 3 contained both grayish blue granular solids and brown sludge. All solid segments recovered from core 198 were yellowish brown or light brown in color, and contained bismuth, which is characteristic of first cycle sludge. All of the segments recovered from tank 241-BX-110, except core 198, segment 4, contained granular material indicative of salt, which suggests that the saltcake and sludge layers may have been disturbed and intermixed in the vicinity of riser 3. The large amounts of drainable liquid in both core samples may indicate that the tank contains more drainable liquid than previously thought, or they may merely result from the pumping action of the sampler piston.

The absence of solids in core 198, segment 1 is not necessarily indicative of an absence of saltcake at that level in the tank. The sample location beneath riser 3 is near the ENRAF™ level measurement device. The 1985 and 1994 photographs show a shallow, circular depression beneath riser 3. This depression may be related to disturbance during the 1978 core sampling event (if that occurred at this location), or it may have been caused by a sludge weight. Numerous liquid level measurement tapes are visible in the vicinity. One possibility is that saltcake was present at this elevation, but that tape or chunks of saltcake restricted the movement of solids into the sampler, while allowing supernatant to be drawn in by the syringe-like pumping action of the sampler piston.

The full depth of the waste was not sampled, and thus the TSAP (Schreiber 1997c) requirement that full vertical profiles of the waste be obtained from two risers was not met.

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All pertinent QC tests were conducted on 1997 core and 1995 auger samples, allowing a full assessment regarding the accuracy and precision of the data. The SAP (Conner 1995) established specific criteria for all analytes. Sample and duplicate pairs with one or more QC results outside the specified criteria were identified by footnotes in the data summary tables.

The standard and spike recovery results provide an estimate of analysis accuracy. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. The precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100. A number of spike recoveries and RPDs were outside the target level for total alpha activity, possibly because of a high dissolved solids content on the sample mount and subsequent self-shielding. Reruns were deemed unnecessary because the sample results were far below the action limit.

Some high RPDs between samples and duplicates for the IC analytes may be attributable to sample homogeneity problems. For core 198, segment 4, the RPDs were 35.9, 31.7, 31.2, 75.6, and 35.6 percent for fluoride, chloride, nitrite, phosphate, and sulfate, respectively. For core 198, segment 1 drainable liquid, the spike recovery for nitrate was -141 percent. This figure may indicate a dilution error, especially considering that the reported nitrate result of 1,450,000 μg/g is inconsistent with a specific gravity of 1.362. The IC results for this supernatant sample are consistently higher for all analytes than those for other drainable liquid samples. The two high RPDs for nitrate can be explained by the fact that the phosphate peak interferes with the resolution of the much smaller nitrate peak. The high RPD and low spike recovery for fluoride in several subsamples can be attributed to the fact that the fluoride peak is very near the baseline and suffers interference from the slightly larger chloride peak. Many ICP analytes also had one or more QC parameters outside the specified limits. The poor spike recoveries for sodium may be caused by the high concentration of sodium in the samples (samples cannot be spiked to levels much greater than already present). The high concentrations of sodium required high dilutions for all ICP samples. These high dilutions in turn can cause poor or meaningless spike recoveries and RPDs for ICP elements that had either very high concentrations or were close to the detection limit. Finally, no sample exceeded the criterion for preparation blanks, so contamination was not a problem.

In summary, the vast majority of QC results were within the boundaries specified in the TSAPs. Except for the IC analysis of core 198, segment 1 drainable liquid, the discrepancies mentioned here and footnoted in the data summary tables should not impact data validity or use.

B3.3 DATA CONSISTENCY CHECKS

Comparing different analytical methods is helpful in assessing the consistency and quality of the data. Several comparisons were possible with the data set provided by the two core samples: a comparison of phosphorous as analyzed by ICP to phosphate as analyzed by IC, and a comparison of sulfur as analyzed by ICP to sulfate as analyzed by IC. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two analytical methods. Agreement between the two methods strengthens the credibility of both results, but poor agreement brings the reliability of the data into question. All analytical mean results were taken from Section B2.0 tables.

The analytical phosphorous mean result as determined by ICP was 16,200 μg/g, which converts to 49,600 μg/g of phosphate. This compared well with the IC phosphate mean result of 43,100 μg/g. The RPD between these two phosphate results was 14 percent. The analytical sulfur mean result as determined by ICP was 3,200 μg/g, which converts to 9,600 μg/g of sulphate. This result compared poorly with the IC sulphate mean result of 6,720 μg/g. The RPD between these two sulfate results was 35.3 percent. The high RPD may reflect the fact that all the core 197 fusion ICP sulfur results included in the mean were "less than" values (i.e., below the relatively high detection limit after sample preparation and dilution), whereas the IC method yielded results for core 197 far below the ICP detection limit. All of the core 198 fusion ICP sulfur analyses were above the detection limit. For core 198, the analytical mean sulfur result as determined by ICP was 4,200 μg/g, which corresponds to 12,600 μg/g of sulfate. This compares somewhat more closely with the core 198 analytical sulfate by IC of 10,850 μg/g. The RPD between these two sulfate determinations, which do not include any values below the detection limit, is 14.8 percent. One possible explanation for this difference could be the presence of water insoluble sulfate species, which would be detected by the KOH fusion ICP technique, but not by the water digest IC method. Sample heterogeneity may also be a contributor. For the 1978 core samples (Bratzel 1980), comparison of different analytical methods is not possible, because the water insoluble results reflect the composition after removal of the water soluble portion of the sample during the water digest. The two results are not duplicate analyses of the same material. The comparison of water soluble (water digest) and water insoluble (fusion digest subsequent to water digest) phosphate results may reflect a transcription error. The water soluble phosphate result is 1.93 percent, which is much less than the 0.0981 percent reported for the water insoluble fraction. Bratzel (1980) was written to assess and correct errors and inconsistencies in previous documentation. For tank 241-BX-110, Horton (1979) reported a soluble phosphate concentration of 1.8 percent and a water insoluble concentration of 9.81 percent. For other first-cycle wastes, water digest IC results are often substantially less than the fusion digest ICP results because of the low solubility of certain phosphate salts, such as bismuth phosphate. The 0.098 percent water insoluble phosphate result in Bratzel (1980) may reflect a transcription error of the 9.8 percent water insoluble phosphate result reported in Horton (1979). This would be more consistent with the distribution of water soluble and insoluble phosphate species noted in Winkelman (1997) for tank 241-BX-107.

B3.3.2 Mass and Charge Balance

The principal objective in performing mass and charge balances is to determine whether the measurements are consistent. In calculating the balances, only the analytes listed in Section B3.4 that were detected at a concentration of 1,000 μg/g or greater were considered.

Except for bismuth and sodium, all cations listed in Tables B3-1 and B3-3 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Because precipitates are neutral species, all positive charge was attributed to the bismuth and sodium cations. The anions listed in Tables B3-2 and B3-4 were assumed to be present as bismuth and sodium salts and were expected to balance the positive charge exhibited by the cations. Phosphate and sulfate, as determined by IC, are assumed to be completely water soluble and appear only in the anion mass and charge calculations.

Table B3-1. Cation Mass and Charge Data (Solids).

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Bismuth	4,020	Bi^{3+}	4,020	58
Iron	2,190	FeO(OH)	3,460	0
Silicon	1,560	SiO_2	3,340	0
Sodium	233,000	Na^+	233,000	10,130
Total			243,820	10,188

Table B3-2. Anion Mass and Charge Data (Solids).

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Aluminum	23,500	AlO_2^-	51,352	934
Chloride	1,360	Cl^-	1,360	38
Chromium	6,220	$Cr_2O_7^{2-}$	12,918	120
Fluoride	4,030	F^-	4,030	212
Nitrate	383,000	NO_3^-	383,000	6,177
Nitrite	10,500	NO_2^-	10,500	228
Oxalate	3,860	$C_2O_4^{2-}$	3,860	88
Phosphate	43,100	PO_4^{3-}	43,100	1,361
Sulfate	6,720	SO_4^{2-}	6,720	140
Total			516,840	9,298

Table B3-3. Cation Mass and Charge Data (Drainable Liquid).

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Potassium	1,921	K^+	1,921	49
Sodium	155,000	Na^+	155,000	6,728
Total			157,000	6,777

Table B3-4. Anion Mass and Charge Data (Drainable Liquid).

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeg/g)
Aluminum	2,939	AlO_2^-	6,422	117
Chloride	3,896	Cl^-	3,896	110
Chromium	2,097	$Cr_2O_7^{2-}$	4,356	40
Nitrate	399,774	NO_3^-	399,774	9,500
Nitrite	37,262	NO_2^-	37,262	810
Phosphate	1,419	PO_4^{3-}	1,419	45
Sulfate	3,014	SO_4^{2-}	3,014	63
Total			456,142	10,684

B3.3.2.1 Solids Mass and Charge Balance. The solids mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from mircrograms per gram to weight percent.

Mass balance = % water + 0.0001 x {total analyte concentration}

= % water + 0.0001 x {AlO_2^- + Bi^{3+} + $Cr_2O_7^{2-}$ + Na^+ + F^- + FeO(OH) + NO_3^- + NO_2^- + PO_4^{-3} + SiO_2 + SO_4^{2-} + $C_2O_4^{2-}$).

The total solids analyte concentration calculated from the above equation is 760,660 μg/g. The mean weight percent water is 36.2 percent, or 362,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 112 percent.

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values.

Total cations (μeq/g) = [Bi^{3-}]/69.7 + [Na^+]/23.0 = 10,188 μeq/g

Total anions (μeq/g) = [AlO_2^-]/59 + [Cl^-]/35.5 + [$Cr_2O_7^{2-}$]/108 + [F^-]/19.0 + [NO2-]/55 + [NO_3^-]/62.0 + [$C_2O_4^{2-}$]/38 + [PO_4^{-3}]/31.7 + [SO_4^-]/48.1 = 9,298 μeq/g.

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge is 1.10.

B3.3.2.2 Drainable Liquid Mass and Charge Balance. The drainable liquid mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from micrograms per gram to weight percent. The mean analytical results were divided by the mean liquid specific gravity of 1.47 to convert from μg/mL units to μg/g. As for solids, analytes with a concentration less than 1,000 μg/g were not considered in the calculations.

Mass balance = % water + 0.0001 x {total analyte concentration}

= % water + 0.0001 x $\{AlO_2^- + Cl^- \; Cr_2O_7^{2-} + Na^+ + NO_3^- + NO_2^- + PO_4^{-3} + SO_4^-\} / 1.47$.

The total drainable liquid analyte concentration calculated from the above equation is 611,000 μg/g. The mean weight percent water is 53.2 percent or 532,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 114 percent.

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values.

Total cations (μeq/g) = $[Na^+]/23 + [K^+]/39 = 6{,}777\ \mu eq/g$

Total anions (μeq/g) = $[AlO_2^-]/59 + [Cl^-]/35.5 + [Cr_2O_7^{2-}]/108 + [NO_3^-]/62.0 + [NO2\text{-}]/55 + [CO_3^{2-}]/30 = 10{,}684\ \mu eq/g$.

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge is 0.888. This is unusual for tank waste because hydroxide is generally present, a factor that is not accounted for in this calculation. Examination of the anion concentration data reveal that the mean nitrate concentration is biased upward by a reported nitrate concentration of 1,450,000 μg/mL for sample S97T001322. The other IC results for this sample are much higher than those for the remaining samples, which may indicate a dilution error or carryover of solids that subsequently dissolved during the analysis. Because this was an opportunistic analysis, with no QC requirements specified in the SAP, the matter was not investigated further by the laboratory. If the nitrate data for sample S97T001322 are omitted when computing the mean concentrations, the mass balance becomes 1.02 percent, and the charge balance ratio becomes 1.233. The difference in the positive and negative charges for drainable liquid samples may be then be attributed to hydroxide based on results from other tanks and because hydroxide is expected to contribute significantly to the negative charge.

B3.3.2.3 Mass and Charge Balance Summary. In summary, the above calculations yield reasonable mass and charge balance values (close to 1.00 for charge balance and 100 percent for mass balance), indicating the analytical results are generally consistent. The mass and charge balances for the drainable liquid results are sensitive to an apparent anomaly in the IC results for sample S97T001322, thereby illustrating the value of this technique for checking that the data are reasonable.

Table B3-5. Mass and Charge Balance Totals.

Totals	Concentrations (μg/g)	Charge (μeq/g)
Solids		
Total from Table B3-1 (cations)	243,820	+10,188
Total from Table B3-2 (anions)	516,840	- 9,298
Water	362,000	n/a
Total	1,123,000	+893
Drainable Liquids		
Total from Table B3-3 (cations)	157,000	+6,777
Total from Table B3-4 (anions)	456,142 (336,867)[1]	-10,684 (-5500)[1]
Water	532,000	n/a
Total	1,145,000 (1,026,000)[1]	-3,907 (+1,277)[1]

Note:

[1]Omitting suspect nitrate result from sample S97T001322.

B3.3.2.4 Mass and Charge Balance for 1978 Core Sample. Mass and charge balances were performed for the 1978 core sample results because these data will be used to assist in characterizing the first-cycle waste layer of tank 241-BX-110. The mass and charge balances will assist in resolving the apparent discrepancy between the phosphate results in Horton (1979) and Bratzel (1980) described in section B.3.3.1. It will be seen that the 9.8 percent insoluble phosphate value in Horton (1979) is more consistent with the remainder of the 1978 core sample results than the 0.0981 percent phosphate value in Bratzel (1980).

Mass and charge balances are computed for the 1997 core samples. Table B3-6 shows the results using the 0.0981 percent insoluble phosphate concentration, and Table B3-7 shows the results using 9.8 percent insoluble phosphate. The mass balance for an insoluble phosphate concentration of 0.0981 percent is 90.4 percent, and the charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge is 1.65. The mass balance for an insoluble phosphate concentration of 9.8 percent is 100.1 percent, and the charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge is 0.914. Both the mass balance and the charge balance close much better with the 9.8 percent insoluble phosphate value than with the 0.0981 percent result. This outcome would favor the 9.8 percent value even more if aluminum and chromium were not assumed to exist as anionic species in the charge balance.

This evaluation highlights some of the difficulties in working with historical sample results. A reasonable conclusion is that the "insoluble" phosphate result of 0.0981 percent in (Bratzel 1980) reflects a transcription error of the 9.8 percent "insoluble" phosphate result in Horton (1979) because low-solubility phosphates such as $BiPO_4$ are not detected during water digest IC analyses, and because of the results of the charge and mass balances. However, in the absence of a well-documented analytical data package, this conclusion relies solely upon inferential and circumstantial evidence. Modern ICP and IC analytical techniques were not available at the time. The possibility exists that the mass and charge balance outcomes stem from the presence of analytes, such as Fe and NO_2^-, which were not reported in Bratzel (1980) or Horton (1979). Alternatively, the reported analyses may contain other errors.

Table B3-6. 1978 Mass and Charge Data (0.0981% insoluble phosphate).

Cationic Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Bismuth	38,400	Bi^{3+}	38,400	551
Silicon	1,780	SiO_2	3,814	0
Sodium	132,000	Na^+	132,000	5,739
Cation Total			174,214	6,290
Anionic Analyte	**Concentration (μg/g)**	**Assumed Species**	**Concentration of Assumed Species (μg/g)**	**Charge (μeq/g)**
Aluminum	18,400	AlO_2^-	40,207	-681
Chromium	1,310	$Cr_2O_7^{2-}$	2,721	-25
Fluoride	1,700	F^-	1,700	-89
Nitrate	140,000	NO_3^-	140,000	-2,258
Phosphate	20,281	PO_4^{3-}	20,281	-640
Sulfate	5,760	SO_4^{2-}	5,760	-120
Anion Total			210,669	-3,815
Water			519,000	0
Total			903,883	2,476

Table B3-7. 1978 Mass and Charge Data (9.8% insoluble phosphate).

Cationic Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Bismuth	38,400	Bi^{3+}	38,400	551
Silicon	1,780	SiO_2	3,814	0
Sodium	132,000	Na^+	132,000	5,739
Cation Total			174,214	6,290
Anionic Analyte	**Concentration (μg/g)**	**Assumed Species**	**Concentration of Assumed Species (μg/g)**	**Charge (μeq/g)**
Aluminum	18,400	AlO_2^-	40,207	-681
Chromium	1,310	$Cr_2O_7^{2-}$	2,721	-25
Fluoride	1,700	F^-	1,700	-89
Nitrate	140,000	NO_3^-	140,000	-2,258
Phosphate	117,300	PO_4^{3-}	117,300	-3,704
Sulfate	5,760	SO_4^{2-}	5,760	-120
Anion Total			307,688	-6,878
Water			519,000	0
Total			1,000,902	-588

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

B3.4.1 Solid Data

A nested ANOVA model was fit to the core segment data. Mean values, and 95 percent confidence intervals on the mean, were determined from the ANOVA. Four variance components were used in the calculations. The variance components represent concentration differences between risers, segments, laboratory samples, and analytical replicates. The model is:

$$Y_{ijk} = \mu + R_i + S_{ij} + L_{ijk} + A_{ijkm},$$

$$I=1,2,\ldots,a;\ j=1,2,\ldots,b_i;\ k=1,2,\ldots,c_{ij};m=1,2,\ldots,n_{ijk}$$

where

Y_{ijkm}	=	concentration from the m^{th} analytical result of the k^{th} sample of the j^{th} segment of the i^{th} riser
μ	=	the mean
Ri	=	the effect of the i^{th} riser
S_{ij}	=	the effect of the j^{th} segment from the i^{th} riser
Lijk	=	the effect of the k^{th} sample from the j^{th} segment of the i^{th} riser
Aijkm	=	the analytical error
a	=	the number of risers
b_i	=	the number of segments from the i^{th} riser
c_{ij}	=	the number of samples from the j^{th} segment of the i^{th} riser
n_{ijk}	=	the number of analytical results from the ijk^{th} sample.

The variables R_i, S_{ij}, and L_{ijk} are random effects. These variables, as well as A_{ijkm}, are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, $\sigma^2(S)$, $\sigma^2(L)$ and $\sigma^2(A)$, respectively.

The restricted maximum likelihood method (REML) was used to estimate the mean concentration and standard deviation of the mean for all analytes with 50 percent or more of their reported values greater than the detection limit. The mean value and standard deviation of the mean were used to calculate the 95 percent confidence intervals. The following table gives the mean, degrees of freedom, and confidence interval for each constituent.

Some analytes had results that were below the detection limit. In these cases, the value of the detection limit was used for nondetected results. For analytes with a majority of results below the detection limit, a simple average is all that is reported.

The lower and upper limits, LL (95 percent) and UL (95 percent), of a two-sided 95 percent confidence interval on the mean were calculated using the following equation:

$$LL(95\%) = \hat{\mu} - t_{(df, 0.025)} \times \hat{\sigma}(\hat{\mu}),$$
$$UL(95\%) = \hat{\mu} + t_{(df, 0.025)} \times \hat{\sigma}(\hat{\mu}).$$

In this equation, $\hat{\mu}$ is the REML estimate of the mean concentration, $\hat{\sigma}(\hat{\mu})$ is the REML estimate of the standard deviation of the mean, and $t_{(df,\ 0.025)}$ is the quantile from Student's t distribution with *df* degrees of freedom. The degrees of freedom equals the number of risers with data minus one. In cases where the lower limit of the confidence interval was negative, it is reported as zero.

Table B3-8. Tank 241-BX-110 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Subdivision Data. (2 sheets)

Analyte	Method	Mean	df	Lower Limit	Upper Limit	Units
Aluminum	ICP:F	2.35E+04	1	0.00E+00	2.17E+05	µg/g
Antimony[1]	ICP:F	<1.44E+03	n/a	n/a	n/a	µg/g
Arsenic[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Barium[1]	ICP:F	<1.06E+03	n/a	n/a	n/a	µg/g
Beryllium[1]	ICP:F	<1.06E+02	n/a	n/a	n/a	µg/g
Bismuth[1]	ICP:F	4.02E+03	1	0.00E+00	2.71E+04	µg/g
Boron[1]	ICP:F	<1.06E+03	n/a	n/a	n/a	µg/g
Bromide[1]	IC:W	<1.07E+03	n/a	n/a	n/a	µg/g
Cadmium[1]	ICP:F	<1.09E+02	n/a	n/a	n/a	µg/g
Calcium[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Cerium[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Chloride	IC:W	1.36E+03	1	0.00E+00	3.70E+03	µg/g
Chromium	ICP:F	6.22E+03	1	0.00E+00	5.63E+04	µg/g
Cobalt[1]	ICP:F	<4.26E+02	n/a	n/a	n/a	µg/g
Copper[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	µg/g
Fluoride	IC:W	5.90E+03	1	0.00E+00	3.85E+04	µg/g
Gross alpha[1]	Alpha:F	8.79E-03	1	0.00E+00	8.06E-02	µCi/g
Iron[1]	ICP:F	2.19E+03	1	0.00E+00	1.59E+04	µg/g
Lanthanum[1]	ICP:F	<1.06E+03	n/a	n/a	n/a	µg/g
Lead[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Lithium[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	µg/g
Magnesium[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Manganese[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	µg/g
Molybdenum[1]	ICP:F	<1.06E+03	n/a	n/a	n/a	µg/g
Neodymium[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	µg/g
Nitrate	IC:W	3.83E+05	1	0.00E+00	1.10E+06	µg/g

Table B3-8. Tank 241-BX-110 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Subdivision Data. (2 sheets)

Analyte	Method	Mean	df	Lower Limit	Upper Limit	Units
Nitrite	IC:W	1.05E+04	1	0.00E+00	2.95E+04	μg/g
Oxalate[1]	IC:W	3.86E+03	1	0.00E+00	1.88E+04	μg/g
Percent water	DSC/TGA	3.62E+01	1	0.00E+00	9.59E+01	%
Phosphate	IC:W	4.31E+04	1	0.00E+00	1.85E+05	μg/g
Phosphorus	ICP:F	1.62E+04	1	0.00E+00	5.61E+04	μg/g
Samarium[1]	ICP:F	<2.13E+03	n/a	n/a	n/a	μg/g
Silicon[1]	ICP:F	1.56E+03	1	0.00E+00	7.77E+03	μg/g
Silver[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	μg/g
Sodium	ICP:F	2.33E+05	1	7.21E+04	3.95E+05	μg/g
Strontium[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	μg/g
Sulfate	IC:W	6.72E+03	1	0.00E+00	5.99E+04	μg/g
Sulfur[1]	ICP:F	3.20E+03	1	0.00E+00	1.63E+04	μg/g
Thallium[1]	ICP:F	<4.26E+03	n/a	n/a	n/a	μg/g
Titanium[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	μg/g
Uranium[1]	ICP:F	<1.06E+04	n/a	n/a	n/a	μg/g
Vanadium[1]	ICP:F	<1.06E+03	n/a	n/a	n/a	μg/g
Zinc[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	μg/g
Zirconium[1]	ICP:F	<2.13E+02	n/a	n/a	n/a	μg/g

Note:
[1]A "less than" value was used in the calculation.

B3.4.2 Liquid Data

The model fit to the liquid data was a nested ANOVA model. The model determined the mean value, and 95 percent confidence interval, for each constituent. Two variance components were used in the calculations. The variance components represent concentration differences between samples taken from different riser, and between analytical replicates. The model is:

$$Y_{ijk} = \mu + R_i + A_{ij},$$

$$I=1,2,\ldots,a;\ j=1,2,\ldots,n_i;$$

where

Y_{ijk} = concentration from the k^{th} analytical result of the j^{th} sample from the i^{th} segment

μ = the mean

R_i = the effect of the i^{th} riser

A_{ij} = the analytical error

a = the number of segments

n_i = the number of analytical results from the i^{th} riser.

The variable R_i is a random effect. This variable, along with A_{ij}, is assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, and $\sigma^2(A)$ respectively. The *df* associated with the standard deviation of the mean is the number of risers with data minus one.

Table B3-9. Tank 241-BX-110 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Subdivision Data. (3 sheets)

Analyte	Method	Mean	df	Lower Limit	Upper Limit	Units
Aluminum	ICP	4.33E+03	1	0.00E+00	1.30E+04	µg/mL
Antimony[1]	ICP	<3.10E+01	n/a	n/a	n/a	µg/mL
Arsenic[1]	ICP	<5.15E+01	n/a	n/a	n/a	µg/mL
Barium[1]	ICP	<2.58E+01	n/a	n/a	n/a	µg/mL
Beryllium[1]	ICP	<2.57E+00	n/a	n/a	n/a	µg/mL
Bismuth[1]	ICP	<1.90E+02	n/a	n/a	n/a	µg/mL
Boron[1]	ICP	3.19E+01	1	3.13E+00	6.07E+01	µg/mL
Bromide[1]	IC	<1.74E+03	n/a	n/a	n/a	µg/mL
Cadmium[1]	ICP	<1.08E+01	n/a	n/a	n/a	µg/mL
Calcium[1]	ICP	<6.39E+01	n/a	n/a	n/a	µg/mL
Cerium[1]	ICP	<5.15E+01	n/a	n/a	n/a	µg/mL
Chloride	IC	5.74E+03	1	0.00E+00	2.82E+04	µg/mL
Chromium	ICP	3.09E+03	1	0.00E+00	2.58E+04	µg/mL
Cobalt[1]	ICP	<1.03E+01	n/a	n/a	n/a	µg/mL

Table B3-9. Tank 241-BX-110 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Subdivision Data. (3 sheets)

Analyte	Method	Mean	df	Lower Limit	Upper Limit	Units
Copper[1]	ICP	<5.15E+00	n/a	n/a	n/a	µg/mL
Fluoride	IC	1.42E+03	1	0.00E+00	6.68E+03	µg/mL
Gross alpha[1]	Alpha rad	<5.51E-03	n/a	n/a	n/a	µCi/mL
Iron[1]	ICP	<3.71E+01	n/a	n/a	n/a	µg/mL
Lanthanum[1]	ICP	<2.58E+01	n/a	n/a	n/a	µg/mL
Lead[1]	ICP	<1.11E+02	n/a	n/a	n/a	µg/mL
Lithium[1]	ICP	<5.15E+00	n/a	n/a	n/a	µg/mL
Magnesium[1]	ICP	<5.15E+01	n/a	n/a	n/a	µg/mL
Manganese[1]	ICP	<5.15E+00	n/a	n/a	n/a	µg/mL
Molybdenum[1]	ICP	2.88E+01	1	8.03E+00	4.95E+01	µg/mL
Neodymium[1]	ICP	<5.15E+01	n/a	n/a	n/a	µg/mL
Nitrate	IC	5.89E+05	1	0.00E+00	2.99E+06	µg/mL
Nitrite	IC	5.49E+04	1	0.00E+00	2.92E+05	µg/mL
Oxalate[1]	IC	<1.97E+03	n/a	n/a	n/a	µg/mL
Percent H_2O	DSC/TGA	5.32E+01	1	4.81E+01	5.82E+01	%
Phosphate[1]	IC	2.09E+03	1	0.00E+00	1.12E+04	µg/mL
Phosphorus	ICP	5.58E+02	1	0.00E+00	1.23E+03	µg/mL
Potassium	ICP	3.03E+03	1	983+02	5.07E+03	µg/mL
Samarium[1]	ICP	<5.15E+01	n/a	n/a	n/a	µg/mL
Silicon	ICP	1.07E+02	1	0.00E+00	3.34E+02	µg/mL
Silver	ICP	1.64E+01	1	0.00E+00	3.31E+01	µg/mL
Sodium	ICP	2.28E+05	1	0.00E+00	5.22E+05	µg/mL
Strontium[1]	ICP	<5.42E+00	n/a	n/a	n/a	µg/mL
Sulfate	IC	4.44E+03	1	0.00E+00	3.21E+04	µg/mL
Sulfur	ICP	1.99E+03	1	0.00E+00	5.24E+03	µg/mL
Thallium[1]	ICP	<1.03E+02	n/a	n/a	n/a	µg/mL
Titanium[1]	ICP	<5.15E+00	n/a	n/a	n/a	µg/mL
Uranium[1]	ICP	<2.57E+02	n/a	n/a	n/a	µg/mL

Table B3-9. Tank 241-BX-110 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Subdivision Data. (3 sheets)

Analyte	Method	Mean	df	Lower Limit	Upper Limit	Units
Vanadium[1]	ICP	<2.58E+01	n/a	n/a	n/a	μg/mL
Zinc[1]	ICP	1.14E+01	1	0.00E+00	8.13E+01	μg/mL
Zirconium[1]	ICP	<5.64E+00	n/a	n/a	n/a	μg/mL

Note:
[1]A "less than" value was used in the calculation.

B4.0 APPENDIX B REFERENCES

ARHCO, 1976, *Analyses of Tank Farm Sample, Sample No. T4433, Tank: 110BX, Received: 4/19/76*, (internal letter, Supervisor, Analytical Services to J. C. Womack, September 17), Atlantic Richfield Hanford Company Operations, Richland, Washington.

Bratzel, D. R., 1980, *Evaluation of Waste Storage Tank Physical and Chemical Characterization Data*, (internal letter 65453-80-265 to F. M. Jungfleisch, September 18), Rockwell Hanford Operations, Richland, Washington.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Supporting Document for the Northeast Quadrant Historical Tank Content Estimate Report for BX Tank Farm*, WHC-SD-WM-ER-311, Rev. 1, Fluor Daniel Northwest Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Buckingham, J. S., 1975, *Analyses of Tank Farm Liquid Samples*, (internal letter to W. P. Metz, May 20), Atlantic Richfield Hanford Company, Richland, Washington.

Caprio, G. S., 1997, *Vapor and Gas Sampling of Single-Shell Tank 241-BX-110 Using the In-Situ Vapor Sampling System*, HNF-SD-WM-RPT-236, Rev. 0, Cogema Engineering Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Conner, J. M., 1998, *Tank Characterization Report for Single-Shell Tank 241-B-107*, HNF-SD-WM-ER-723, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

De Lorenzo, D. S., A. T. DiCenso, D. B. Hiller, K. W. Johnson, J. H. Rutherford, D. J. Smith, and B. C. Simpson, 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Evans, J. C., K. H. Pool, B. L. Thomas, K. B. Olsen, J. S. Fruchter, and K. L. Silvers, 1997, *Headspace Vapor Characterization of Hanford Waste Tank 241-BX-110: Results from Samples Collected on 4/30/96*, PNNL-11256, Pacific Northwest National Laboratory, Richland, Washington.

Hardy, D. B., 1998, *45-Day Safety Screening Results and Final Report for Tank 241-BX-110, Auger Samples 95-AUG-045 and 95-AUG-046*, WHC-SD-WM-DP-155, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

Homi, C. S., 1995, *Vapor Sampling and Analysis Plan*, WHC-SD-WM-TP-335, Rev. 0G, Westinghouse Hanford Company, Richland, Washington.

Horton, J. E., 1979, *Physical and Chemical Characterization of Core Segment #3, Tank 110BX*, (internal letter 60120-79-024 to D. J. Flesher, February 14), Rockwell Hanford Operations, Richland, Washington.

Jungfleisch, F. M., 1980, *Hanford High-Level Defense Waste Characterization - A Status Report*, RHO-CD-1019, Rockwell Hanford Operations, Richland, Washington.

Kupfer, M. J., W. W. Schulz, and J. T. Slankas, 1995, *Strategy for Sampling Hanford Site Tank Wastes for Development of Disposal Technology*, WHC-SD-WM-TA-154, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Kristofzski, J. G.1995, *Directions for Opportunistic Analyses*, (memorandum 7310-95-102 to B.G. Griffin, September 8), Westinghouse Hanford Company, Richland, Washington).

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Nuzum, J. L., 1998, Tank 241-BX-110, *Cores 197 and 198 Analytical Results for the Final Report*, HNF-SD-WM-DP-256, Rev. 0A, Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

Osborne, J. W., and L. L. Buckley, 1995, *Data Quality Objectives for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Schreiber, R. D., 1995a, *45-Day Safety Screening Results and Final Report for Tank 241-BX-110, Auger Samples 95-AUG-045 and 95-AUG-046*, WHC-SD-WP-DP-155, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Schreiber, R. D., 1995b, *Tank 241-BX-110 Auger Sampling and Analysis Plan*, WHC-SD-WM-TSAP-038, Rev. 0, Westinghouse Hanford Corporation, Richland, Washington.

Schreiber, R. D., 1997a, *Clarification Regarding Near Infrared Spectrospory Analysis Request for Tank Waste Samples*, (internal memorandum to B. A. Crawford and A. D. Rice, August 12), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington

Schreiber, R. D., 1997b, *Memorandum of Understanding for the Organic Complexant Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Schreiber, R. D., 1997c, *Tank 241-BX-110 Rotary Mode Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-112, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Sutey, M. J., 1993, *Waste Compatibility Assessment of Tank 241-AN-101 With Tanks 241-BX-110 and 241-BX-111*, (internal letter 7C242-93-029 to S. D. Godfrey, August 3), Westinghouse Hanford Company, Richland, Washington.

Turner, D. A., 1995, *Data Quality Objectives to Support Resolution of the Organic Fuel Rich Tank Safety Issue*, WHC-SD-WM-DQO-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Weiss, R. L., 1990, (DSI to V. C. Boyles, March 16), Westinghouse Hanford Company, Richland, Washington.

WHC, 1995a, *Operating Specification for Watch List Tanks*, OSD-T-151-00030, Rev./Mod. B-9, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995b, *Perform Auger Sampling of Ferrocyanide, Organic, Organic/Ferrocyanide, or Non-Watch List Storage Tanks*, Tank Farm Operating Procedure, TO-080-500, Rev./Mod. B-7, Westinghouse Hanford Company, Richland, Washington.

Winkelman, W. D., 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-107*, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C documents the results of the analyses and statistical and numerical manipulations required by the DQOs applicable for tank 241-BX-110 and contains:

- **Section C1.0**: Statistical analysis and numerical manipulations supporting the safety screening DQO (Dukelow et al. 1995).
- **Section C2.0**: Appendix C references.

C1.0 STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVE

The safety screening DQO (Dukelow et al. 1995) defines decision limits in terms of one-sided 95 percent confidence intervals. The safety screening DQO limits are 41 μCi/g for gross alpha and 480 J/g for DSC. Confidence intervals were calculated for the mean values from each laboratory sample. Gross alpha results are shown in Table C1-1. The DSC results are shown in Table C1-2.

The upper limit of a one-sided 95 percent confidence interval on the mean is

$$\hat{\mu} + t_{(df,0.05)}\,\hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with *df* degrees of freedom. The degrees of freedom equals the number of samples minus one.

For sample numbers with at least one value above the detection limit, the upper limit of a 95 percent confidence interval is given in Table C1-1. Each confidence interval can be used to make the following statement: If the upper limit is less than 32.8 μCi/g (61.5 μCi/mL for drainable liquid), then reject the null hypothesis that the alpha is greater than or equal to 32.8 μCi/g (61.5 μCi/mL for drainable liquid) at the 0.05 level of significance.

Eleven of the 28 gross alpha results were above the detection limit. The upper limit closest to the threshold was 0.0319 μCi/g for core 198, segment 4, lower half . This result is well below the limit of 32.8 μCi/g.

Table C1-1. 95 Percent Upper Confidence Limits for Gross Alpha.

Laboratory Sample Identification	Description	$\hat{\mu}$	df	Upper Limit	Units
S95T002946F	Riser 3, auger	1.10E-02	1	1.63E-02	μCi/g
S97T001278[1]	Core 197, segment 2	6.65E-03	1	1.70E-02	μCi/mL
S97T001280F	Core 197, segment 1, lower half	4.77E-03	1	9.69E-03	μCi/g
S97T001307F	Core 198, segment 2, lower half	9.96E-03	1	1.46E-02	μCi/g
S97T001309F	Core 198, segment 3, lower half	1.16E-02	1	1.82E-02	μCi/g
S97T001328F	Core 198, segment 4, lower half	2.18E-02	1	3.19E-02	μCi/g

Note:
[1]A "less than" value was used in the calculations.

Four of the 42 DSC results had an exothermic reaction. For each laboratory sample identification number, a 95 percent upper confidence limit is given in Table C1-2. All of the results are expressed on a dry weight basis. Each confidence interval can be used to make the following statement: If the upper limit is less than 480 J/g, then reject the null hypothesis that DSC is greater than or equal to 480 Joules/g at the 0.05 level of significance. The maximum upper limit to a 95 percent confidence interval on the mean for DSC was 58 J/g dry weight for the auger sample from riser 6. This result is below the threshold limit of 480 J/g.

Table C1-2. 95 Percent Upper Confidence Limits for Differential Scanning Calorimetry.

Laboratory Sample Identification	Description	$\hat{\mu}$	df	Upper Limit	Units
S95T002903[1]	Riser 6 auger	1.94E+01	2	5.80E+01	J/g dry weight
S95T002945[1]	Riser 3 auger	11.07E+00	2	3.16E+01	J/g dry weight

Note:
[1]An endothermic result was used as an exothermic value of 0 J/g.

C2.0 APPENDIX C REFERENCES

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE SHELL-TANK 241-BX-110

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BX-110

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-BX-110 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

Available information useful for assessment of tank 241-BX-110 inventories includes the following.

- Two push core samples obtained in May 1997 from two widely spaced risers. One sample represents the top 48 cm (19 in.) of waste in the tank, which has an estimated total depth of 180 cm (71 in.). The other core sample represents 148 cm (58 in.) of the waste. A full suite of IC anions and ICP cations were obtained. The only radionuclide analysis performed was total alpha.

- Two auger samples obtained in October 1995 from the same two widely spaced risers. The samples represent the top 30 cm (12 in.) of waste in the tank, which has an estimated total depth of 180 cm (71 in.). Because of the narrow focus of the sample event, only five analyses were performed.

- Core sample obtained in 1978. One segment was recovered from the waste near the tank bottom (see Appendix B).

- Analytical data for tanks that contain the 1C waste type from the $BiPO_4$ process assumed to be in tank 241-BX-110.

- Analytical data for tanks that contain the B and BY saltcake waste types assumed to be in tank 241-BX-110.

- The predicted tank content inventories from the HDW model (Agnew et al. 1997a).

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Previous best-basis inventories (LMHC 1998) and HDW model inventories (Agnew et al 1997a) are compared in Tables D2-1 and D2-2. The chemical species are reported without charge designation according to the best-basis inventory convention. The tank volume used to generate the HDW inventory is 749 kL (198 kgal) of solids and no supernatant. The volume reported in Hanlon (1998) is slightly higher (783 kL [207 kgal]) and includes 11 kL (3 kgal) of supernatant and a 23-kL (6-kgal) solid shelf in addition to the 749 kL (198 kgal) used in the HDW model.

The previous best-basis inventory uses the Hanlon (1998) solids volume of 772 kL (204 kgal) and 11 kL (3 kgal) of supernatant. The previous best-basis inventory was developed before the 1997 core sampling data became available. Both the HDW inventory and the previous best-basis inventory are derived using the distribution of 1C and BYSltCk waste types in the TLM (Agnew et al. 1997a), which, in turn, is based on the waste transaction data in the WSTRS (Agnew et al. 1997b). The previous best-basis inventory extrapolates analytical data from other tanks containing the same waste types and utilizes information from the HDW model to fill in the gaps where no analytical data are available. Most chemical analytes are comparable (within a factor of 2) between the HDW model and the previous best-basis inventory.

Because limited radionuclide analytical data were available from other tanks containing the same waste types, the previous best-basis inventory relied heavily on the HDW model (Agnew et al. 1997a) radionuclides. Consequently, Table D2-2 compares only those radionuclides for which the previous best-basis inventory relied on data other than the HDW model.

Table D2-1. Inventory Estimates for Nonradioactive Components in Tank 241-BX-110.

Analyte	HDW Model Inventory Estimate[1] (kg)	Previous Best-Basis Inventory[2] (kg)
Al	16,900	15,800
Bi	7,540	13,800
Ca	2,230	2,070
Cl	1,400	1,350
TIC as CO_3	7,460	36,400
Cr	606	1,410
F	1,750	9,830
Fe	11,500	7,620
Hg	12.8	49.7
K	406	869
La	0.0452	0.0713
Mn	28.3	266
Na	1.17E+05	1.26E+05
Ni	168	<32
NO_2	19,700	27,300
NO_3	1.01E+05	1.56E+05
OH_{TOTAL}	63,200	34,400
Pb	187	187
PO_4	64,100	15,300
Si	3,460	6,700
SO_4	5,940	8,950
Sr	0	122
TOC	1,160	2,070
U_{TOTAL}	28,100	933
Zr	13.6	<64

Notes:
[1] Agnew et al. (1997a)
[2] LMHC (1998)

Table D2-2. Inventory Estimates for Radioactive Components in Tank 241-BX-110.

Radionuclide	HDW Model Inventory[1] (Ci)	Previous Best-Basis Inventory Estimate[2] (Ci)
Strontium-90	26,900	11,300
Yttrium-90	27,000	11,300
Barium-137 metastable	29,800	62,300
Cesium-137	31,500	65,900

Notes:

[1]Agnew et al. (1997a), decayed to January 1, 1994

[2] LMHC (1998), decayed to January 1, 1994

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would have an effect on HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

The following abbreviations are used to designate waste types:

BSltCk	=	Salt cake resulting from evaporation of supernatants in 242-B Evaporator
BYSltCk	=	Salt cake resulting from in-tank solidification of supernatants (evaporation) in BY Tank Farm using in-tank heaters
CW	=	$BiPO_4$ process aluminum cladding waste
CWP	=	PUREX process cladding waste
1C1	=	First decontamination cycle $BiPO_4$ waste (also contains some CW used to neutralize the 1C waste) produced from 1944 through 1949
1C2	=	First decontamination cycle $BiPO_4$ waste (also contains some CW used to neutralize the 1C waste) produced from 1950 through 1956

EB-ITS	=	Hill et al. (1995) designation for evaporator bottoms. Comparable to BYSltCk
ITS	=	In-tank solidification.

Model-Based Prediction of Current Waste Types and Volumes (Agnew et al. 1997a)

Waste type	Waste Volume kL	(kgal)
1C1	219.5	(58)
1C2	371	(98)
BYSltCk	159	(42)

Beginning in 1949, tank 241-BX-110 received 1C waste from the B Plant $BiPO_4$ process. Tank 241-BX-110 is the first tank in a cascade that includes tanks 241-BX-111 and 241-BX-112. Most of the waste solids from the 1C waste settled in tank 241-BX-110, although some solids were cascaded to tank 241-BX-111 from 1949 to 1950.

The supernatant was decanted to the B-039 crib in 1953 to 1954. Tank 241-BX-110 then received 242-B evaporator bottoms from tank 241-B-105 in 1954, which may have led to the formation of BSltCk solids. The supernatant was later transferred to tank 241-C-111 for ferrocyanide scavenging. Flush water, plutonium-uranium extraction (PUREX) process cladding waste supernatants, and B Plant ion exchange waste from cesium recovery were received by tank 241-BX-110 in 1968 and 1969. The tank 241-BX-110 solids levels (Agnew et al. 1997b) varied considerably during this period. As much as 731 kL (193 kgal) of BSltCk and CW solids may have been deposited in the tank. However, after the 1969 transfers of B Plant IX waste into tank 241-BX-110, the net increase in solids level since the completion of the BiPO4 campaign was only 87 kL (23 kgal). This suggests that most of the soluble BSltCk and CW solids were dissolved and removed from the tank by the flush water, supernatant, and IX waste transfers.

Waste bottoms from operation of the ITS evaporator unit in BY Tank Farm were transferred to tank 241-BX-110 in 1972 and 1973. Following transfer of salt well liquid from tank 241-BX-110, it is expected that 1C waste fills the bottom of the tank with a layer of saltcake from the ITS campaign (BYSltCk) on the surface. Some PUREX cladding waste and/or 242-B Evaporator saltcake (BSltCk) may also be present.

Based on surface-level gauge measurements and photographic evaluations, the estimate of tank volume was changed in 1995 (Hanlon 1996) to 783 kL (207 kgal) from 749 kL (198 kgal) when a 60-cm by 90-cm (24- in. by 36- in.) ledge on the perimeter of the tank was taken into account. Of the 783 kL (207 kgal), 11 kL (3 kgal) of supernatant was estimated based on the photographic evaluation. Agnew et al. (1997a) continues to use the 749 kL (198 kgal) estimate and does not predict any supernatant in the tank.

Based on close examination of the waste transfer records (Agnew et al. 1997b), it is concluded that the Agnew et al. (1997a) basis assumes that no BSltCk or CWP remained in tank 241-BX-110 before the receipt of ITS waste in 1972. Agnew et al (1997a) ignore the 503 kL (133 kgal) solids level measured in 1953 before the decant of 1C supernatants to the B-039 crib, and assume that the entire 590 kL (156 kgal) solids level measured in 1969 consists of 1C sludge. The remaining 159 kL (42 kgal) of solids in the main waste mass of tank 241-BX-110 are assumed then to be BYSltCk. Given the solubility of BSltCk in the intervening transfers of flush water, CWP, and IX waste, and the fact that most of the CWP solids may have settled out in tank 241-C-102 before transfer to tank 241-BX-110, this provides a reasonable approximation for the relative proportions of the 1C and BYSltCk waste types in the main 749 kL (198 kgal) waste mass in tank 241-BX-110.

However, the following scenario is more in line with the transfer history. The tank contained 503 kL (133 kgal) of 1C solids at the conclusion of 1C waste receipt. The tank contained 893 kL (236 kgal) of solids after receiving 242-B Evaporator bottoms from tank 241-B-105, so 390 kL (103 kgal) (all solids above the 503 kL (133 kgal) 1C sludge level) of BSltCk were deposited. The solids level decreased to 746 kL (197 kgal) following scavenging and BXR vault flushes; therefore, only 242 kL (64 kgal) of BSltCk remained by 1963. The CWP transfers from tank 241-C-102 increased the solids level to 1,098 kL (277 kgal). However, catch tank transfers and B Plant IX waste reduced the solids inventory to 509 kL (156 kgal) by the start of the ITS campaign, leaving behind the 503 kL (133 kgal) of 1C waste and 87 kL (23 kgal) of BSltCk. The balance of the solids in the tank are BYSltCk produced by the ITS campaigns. This includes 159 kL (42 kgal) of solids in the main waste mass and the 23 kL (6 kgal) of solids in the shelf, which are assumed to be BYSltCk, for a total of 182 kL (48 kgal) of BYSltCk. The location, light color, and crystalline appearance of the shelf support the assumption that the shelf consists of BYSltCk. Under this scenario, the tank is assumed to contain 503 kL (133 kgal) of 1C sludge, 87 kL (23 kgal) of BSltCk, 182 kL (48 kgal) of BYSltCk, and 11 kL (3 kgal) of supernatant. This breakdown of waste types is used in the remainder of this best-basis inventory evaluation. In addition, 11 kL (3 kgal) of supernatant are assumed based on the revised volume estimates, the successful grab sampling of supernatant in 1990, and the drainable liquids noted in core and auger samples.

D3.2 BASIS FOR ASSESSING 1C WASTE IN TANK 241-BX-110

An estimate of the composition of the 1C sludge layer can be made by comparing the sludge layer of tank 241-BX-110 to other tanks containing 1C sludge. In the $BiPO_4$ process from 1944 through 1954, the 1C waste was combined with the CW stream before being discharged from the plant (Anderson 1990).

Agnew et al. (1997a) identifies 1C waste produced from 1944 through 1949 as HDW waste type 1C1 and designates 1C waste produced from 1950 onward as HDW type 1C2. Agnew et al. (1997a) state that tank 241-BX-110 received 1,590 kL (420 kgal) of 1C1 waste through 1949 and subsequently received 2,420 kL (640 kgal) of 1C2 waste. Assuming a solids content of 13.7 percent and 14.3 percent for 1C1 and 1C2 wastes, respectively (Agnew et al. 1997a), the 1C1 waste layer in tank 241-BX-110 consists of 38.6 percent 1C1 waste and 61.4 percent 1C2 waste. Because the densities of 1C1 and 1C2 wastes are nearly identical, subsequent discussions of the HDW 1C waste type in tank 241-BX-110 will refer to this blend of 1C1 and 1C2 wastes.

Several tanks, including the following, received 1C/CW waste directly from T Plant: 241-T-104, 241-T-107, 241-TX-109, 241-TX-113, 241-U-110, 241-TY-101, and 241-TY-103. Sample data are not available for the solid layers of tanks 241-TX-109, 241-TX-110, or 241-TX-113. The 1C waste was mixed with substantial quantities of other wastes in tanks 241-TY-101, 241-TY-103, and 241-U-110, making it difficult to accurately determine the composition of the 1C/CW waste sludge. Tanks 241-T-104 and 241-T-107 provide some of the best examples of T Plant 1C/CW sludge composition.

Several other tanks received 1C/CW waste directly from the B Plant $BiPO_4$ process 1C operations. These tanks included 241-C-110 (Benar 1997b), 241-BX-112 (Kupfer and Winward 1997), and 241-BX-107 (Winkelman 1997). Tanks 241-C-110, 241-BX-107, and 241-BX-112 are the best examples of B Plant 1C/CW waste because these tanks contain 1C/CW waste almost exclusively, and analyses of core samples are available for these tanks. Calculations show that the composition of the B Plant 1C waste and the T Plant 1C waste are consistent with the flowsheet basis (Schneider 1951 and Kupfer et al. 1997) for the first cycle $BiPO_4$ process, and no significant plant to plant differences exist. The relative concentrations of components expected to precipitate 100 percent to the waste solids (e.g., Bi, Fe, Si, Zr) are consistent (up to a factor of three) between the samples and are approximately proportionate to the relative 1C flowsheet concentrations for those components (see Appendix C of Kupfer et al. 1997). Therefore, it can be concluded that the sample data for these tanks are consistent with the flowsheet basis. In addition, the concentrations of components that partition between solids and supernatants are comparable between the tanks and represent expected chemical behavior. Kupfer et al. (1997) describe the process for applying component concentration factors for reconciling process-based flowsheet compositions and sample data to determine the consistency of the sample and the flowsheet basis.

The composition of waste in tanks 241-T-104, 241-T-107, 241-BX-112, 241-BX-107, and 241-C-110, based on the respective TCRs (Sasaki 1997a and 1997b, Kupfer and Winward 1997, Winkelman 1997, and Benar 1997b), are compared in Table D3-1 to the mean composition of segments 3 and 4 of core 198 from tank 241-BX-110. These two segments are expected to represent the lower 466 kL (123 kgal) of waste in the tank, which is assumed to consist entirely of 1C sludge. Shown for comparison are the 1978 core sample results (Bratzel 1980), including the 9.8 percent "insoluble" phosphate result (Horton 1979). Table D3-1 includes the HDW model composition for 1C waste from Agnew et al. (1997a).

An examination of the data from the tanks listed in Tables D3-1 and D3-2 reveals that the average results for core 198, segment 3 and 4, from tank 241-BX-110 are significantly higher in aluminum, sodium, NO_3, and density, and lower in bismuth, PO_4, and moisture than any other tanks. This is consistent with the admixture of typical saltcake constituents such as sodium nitrate and sodium aluminate into a 1C sludge. The high aluminum concentration may indicate the presence of cladding waste.

The 1978 core sample results are included in Table D3-1 for comparison. This sample was recovered from the lower 51 cm (20 in.) of sludge in tank 241-BX-110 before the waste was disturbed while probing for the saltcake-sludge interface (Jungfleisch 1980). The 1978 core sample more closely resembles the HDW 1C sludge composition and the mean values of the comparison tanks than do the 1997 cores. The 1978 core sample has somewhat higher bismuth and lanthanum and lower uranium and fluoride than are found in any of the other samples.

Table D3-1. Composition of 1C Waste in Tank 241-BX-110, Water-Free Basis. (3 sheets)

Analyte	BX-107[1]	BX-112[2]	C-110[3]	T-104[4]	T-107[5]	Average conc.	HDW Model 1C[6]	BX-110 C198:3&4	BX-110 1978 Core[7]
Chemical	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g
Ag	<2	<128	<2	<4	14	<30	n/r	<213	n/r
Al	34,963	37,466	35,930	54,915	30,370	38,729	28,055	80,137	38,254
Bi	54,523	48,209	33,920	64,068	20,741	44,292	26,617	10,746	79,834
Ca	968	6,915	<967	4,915	2,778	3,894	6,247	<3,185	n/r
Cd	6	<164	13	18	12	12	n/r	<107	<699
Cl	2,787	2,893	2,739	2,271	1,013	2,341	2,337	1,920	n/r
CO_3	14,181	28,926	26,382	<1695	27,407	24,224	9,354	4,236	n/r
Cr	2,367	3,554	1,166	3,054	656	2,159	536	2,504	2,723
F	22,469	29,477	19,070	29,051	21,296	24,273	5,607	13,155	3,534
Fe	27,139	26,061	26,884	30,576	58,333	33,799	40,109	4,886	n/r
Hg	1.38	n/r	1.12	<0.42	0.25	<0.793	41	n/r	n/r
K	643	1,118	1,405	302	59	705	560	n/r	n/r
La	<4	<430	19	<35	<4	<98	0	<1,741	314
Mn	158	890	90	209	411	352	0	<347	n/r
Na	2.50E+05	2.25E+05	2.08E+05	2.19E+05	2.41E+05	2.29E+05	2.45E+05	3.78E+05	2.74E+05
Ni	30	<8	<61	38	541	203	149	n/r	n/r
NO_2	30,073	70,523	23,342	13,831	21,852	31,924	26,427	14,966	n/r
NO_3	3.35E+05	2.07E+05	2.76E+05	1.97E+05	1.40E+05	2.31E+05	1.30E+05	5.72E+05	2.91E+05
OH_{TOTAL}	n/r	n/r	n/r	n/r	n/r	n/r	130,571	n/r	n/r
Pb	154	<912	648	169	1,474	611	0	<3,465	n/r

Table D3-1. Composition of 1C Waste in Tank 241-BX-110, Water-Free Basis. (3 sheets)

Analyte	BX-107[1]	BX-112[2]	C-110[3]	T-104[4]	T-107[5]	Average conc.	HDW Model 1C[6]	BX-110 C198:3&4	BX-110 1978 Core[7]
Chemical (Cont'd)	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
P as PO_4	1.75E+05	1.63E+05	1.57E+05	2.57E+05	2.11E+05	1.93E+05	2.24E+05	68,496	2.44E+05
Si	16,577	23,140	17,990	22,102	11,241	18,210	11,082	3,669	3,701
S as SO_4	33,496	17,851	29,899	13,017	19,630	22,779	10,611	19,620	11,975
Sr	411	364	327	336	1,781	644	0	<347	n/r
TOC	1,951	2,642	<1698	<1932	3,148	2,580	0	730	1,599
U	11,834	2,865	5,377	3,041	41,852	12,994	96,186	<17,406	99
Zr	333	<215	432	229	209	301	46	<347	<644
Radionuclide[8]	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g
^{241}Am	0.0138	<0.460	<0.0239	<0.0586	<0.134	<0.13915	4.95E-04	n/r	n/r
^{14}C	6.360E-04	n/r	8.04E-04	<1.53E-04	<3.54E-04	<0.00051	2.48E-04	n/r	n/r
^{60}Co	<0.0139	<0.0366	<0.0746	<7.39E-04	<0.0244	<0.0294	5.78E-05	n/r	n/r
^{137}Cs	41.3	143	47.2	0.654	22.4	50.9	26.9	n/r	71.1
^{154}Eu	<0.0377	<0.0926	<0.208	0.01	<0.0920	<0.088	0.00105	n/r	n/r
^{155}Eu	<0.0719	<0.463	<0.229	0.00976	<0.109	<0.177	0.00567	n/r	n/r
$^{239/240}$Pu	0.0140	n/r	0.201	n/r	n/r	0.170	0.0928	n/r	n/r

Table D3-1. Composition of 1C Waste in Tank 241-BX-110, Water-Free Basis. (3 sheets)

Analyte	BX-107[1]	BX-112[2]	C-110[3]	T-104[4]	T-107[5]	Average conc.	HDW Model 1C[6]	BX-110 C198:3&4	BX-110 1978 Core[7]
Radionuclide[8] (Cont'd)	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g
^{90}Sr	23.4	16.7	12.0	8.6	196	51.4	23.6	n/r	11.4
^{99}Tc	0.0902	n/r	0.0829	<0.00214	<0.0935	<0.0756	0.00172	n/r	n/r

Notes:

n/r = not reported

[1]Winkelman (1997)
[2]Kupfer and Winward (1997)
[3]Benar (1997b)
[4]Sasaki (1997a)
[5]Sasaki (1997b)
[6]Blend of 38.6 percent 1C1 and 61.4 percent 1C2 defined waste (Agnew et al. 1997a)
[7]Bratzel (1980); includes 9.8 percent "insoluble" fraction phosphate result per Horton (1979).
[8]Radionuclides are decayed to January 1, 1994.

Table D3-2. Summary of Tank 241-BX-110 Analytical Data on a Water-Free Basis. (2 sheets)

Analyte	C197-1[1] LH μg/g	C197-2[1] LH μg/g	C197-2A[1] LH μg/g	C198-2[1] UH μg/g	C198-2[1] LH μg/g	C198-3[1] LH μg/g	C198-4[1] LH μg/g
Al	26,112	17,650	1,986	47,952	22,008	46,212	114,063
Bi	<4,120	<3,985	<2,471	12,765	3,865	4,773	16,719
Ca	<4,120	<3,985	<2,471	<3,618	<2,971	<3,197	<3,733
Cl	4,275	2,744	1,076	2,167	1,554	1,652	2,188
TIC as CO_3	17,021	9,586	5,393	8,618	6,011	4,530	3,941
Cr	44,101	13,139	930	8,959	3,012	2,924	2,083
F	8,994	8,177	956	18,771	9,532	7,561	18,750
Fe	<2,050	<1,992	<1,236	9,710	1,912	2,515	7,257
Hg	n/r	n/r	n/r	n/r	n/r	n/r	n/r
K	n/r	n/r	n/r	n/r	n/r	n/r	n/r
La	<2,050	<1,992	<1,236	<1,809	<1,486	<1,606	<1,875
Mn	<412	<398	<247	<362	<297	<320	<373
Na	3.38E+05	4.45E+05	3.07E+05	3.72E+05	3.73E+05	3.80E+05	3.75E+05
Ni	n/r	n/r	n/r	n/r	n/r	n/r	n/r
NO_2	34,236	19,549	8,118	17,918	11,307	13,561	16,372
NO_3	4.45E+05	7.99E+05	7.14E+05	3.84E+05	6.45E+05	6.95E+05	4.48E+05
Pb	<4,122	<3,985	<2,471	<3,618	<2,971	<3,197	<3,733
P as PO_4	75,170	81,912	19,716	116,982	72,561	51,161	85,831
PO_4	86,847	72,180	14,088	113,652	74,140	50,000	118,056
Si	<2,050	<1,992	<1,236	3,874	2,050	2,061	5,278
S as SO_4	<12,360	<11,955	<7,413	32,918	10,028	14,500	24,740
SO_4	6,093	4,643	2,125	27,133	9,587	12,015	21,875
Sr	<412	<398	<247	<362	<297	<320	<373
TOC	5,358	3,327	1,166	3,771	1,513	894	566

Table D3-2. Summary of Tank 241-BX-110 Analytical Data on a Water-Free Basis. (2 sheets)

Analyte	C197-1[1] LH µg/g	C197-2[1] LH µg/g	C197-2A[1] LH µg/g	C198-2[1] UH µg/g	C198-2[1] LH µg/g	C198-3[1] LH µg/g	C198-4[1] LH µg/g
U_{TOTAL}	<20,503	<19,925	<12,356	<18,089	<14,856	<16,061	<18,750
Zr	<412	<398	<247	<362	<297	<320	<373
Total alpha (µCi/g)	0.00923	<0.00547	<0.00202	n/r	0.0137	0.0176	0.0378

Note:

LH = lower half
UH = upper half

[1]Core number and section (e.g., C197-1 = core 197, section 1)

To provide a common basis for comparison of the data in Table D3-1, the reported water mass was removed from the results (i.e., the results are compared on a water-free basis) To facilitate comparison with analytical results for other segments of tank 241-BX-110, the analytical results in Appendix B are summarized on a water-free basis in Table D3-2.

D3.3 BASIS FOR ASSESSING SALTCAKE INVENTORIES IN TANK 241-BX-110

Tank 241-BX-110 is expected to contain 1C sludge beneath a layer of BSltCk which, in turn, is overlain by a BYSltCk layer. Because all samples except segment 4 of core 198 contained granular or crystalline material, all core samples were compared with each type of saltcake to determine the demarcation between the layers. Both types of saltcake consist primarily of sodium nitrate but differ in concentrations of species such as bismuth, phosphate, aluminum, and sulfate, for which sample results are available, and other species such as radionuclides, for which sample results are not available. BSltCk contains comparatively more bismuth, phosphate, and uranium; while BYSltCk contains comparatively more aluminum, sulfate, and fission products.

D3.3.1 Basis for Assessing BY Saltcake Layer in Tank 241-BX-110

As described by Agnew et al. (1997a), the waste consists of a layer of 1C sludge at the bottom of the tank, overlain by BYSltCk. The present evaluation assumes a layer of BSltCk between the sludge and the BYSltCk. The analytical data from core sampling of tank 241-BX-110 in June 1997 (Nuzum 1998) indicate granular or crystalline material in all samples except for segment 4 of core 198. To determine the demarcation between the BSltCk and BYSltCk layers, all sample segments are compared with accepted compositions of BY saltcake.

A defined waste composition for BYSltCk is provided in Agnew et al. (1997a). Because of the complicated waste supernatant transfer history of feed to the ITS campaign and the lack of a flowsheet basis for the waste, it is difficult to perform an independent assessment to estimate a saltcake composition that can be compared to the analytical data and model-based BYSltCk composition. However, some samples from several BY Tank Farm tanks containing saltcake have been analyzed and reported. Table D3-4 summarizes the compositions of saltcake from tanks 241-BY-105, 241-BY-106, and 241-BY-110 based on segment-level analysis (Simpson et al. 1996a and 1996b and Bell et al. 1996). The table also shows the average concentrations of waste components for the BY Tank Farm saltcake and the BYSltCk defined waste composition from Agnew et al. (1997a). To provide a common basis for comparison of the data in Table D3-4, the reported water mass was removed from the results (i.e., the results are compared on a water-free basis). Table D3-3 includes the mean analytical results of Tank 241-BX-110, core 197, for comparison with this saltcake waste type.

Table D3-3. Composition of BY Saltcake in Tank 241-BX-110, Dry Weight Basis.[1] (2 sheets)

Analyte	BY-105[2] (μg/g)	BY-106[3] (μg/g)	BY-110[4] (μg/g)	Mean (μg/g)	BX-110 C-197 (μg/g)	BYSltCk[5] (μg/g)
Ag	21	19	23	21	<352	n/r
Al	21,931	27,383	18,359	22,558	15,250	54,890
Bi	66	n/r	n/r	66	<3,525	180
B	n/r	152	120	136	<1,759	n/r
Cd	8	11	27	15	<190	n/r
Ca	257	413	521	397	<3,525	2,811
Cl	1,069	2,765	2,930	2,255	2,698	4,448
Cr	383	1,148	3,776	1,769	19,390	2,753
Co	10	n/r	n/r	10	<703	n/r
Cu	9	n/r	n/r	9	<352	n/r
F	4,887	6,886	7,057	6,277	6,042	1,019

Table D3-3. Composition of BY Saltcake in Tank 241-BX-110, Dry Weight Basis.[1] (2 sheets)

Analyte	BY-105[2] (μg/g)	BY-106[3] (μg/g)	BY-110[4] (μg/g)	Mean (μg/g)	BX-110 C-197 (μg/g)	BYSltCk[5] (μg/g)
Fe	567	289	1,203	686	<1,759	1,176
Pb	60	87	169	105	<3,526	1,131
Mn	65	13	69	49	<352	171
Na	2.36E+05	2.72E+05	3.08E+05	2.72E+05	3.64E+05	289,835
Ni	90	64	251	135	n/r	764
NO_3	5.85E+05	4.42E+05	2.40E+05	4.22E+05	6.52E+05	390,449
NO_2	11,216	43,087	39,844	31,382	20,634	73,990
Oxalate	13,468	12,067	17,708	14,415	10,500	0
PO_4	5,828	7,074	18,490	10,464	58,933	6,274
K	849	3,315	2,513	2,226	n/r	1,500
Si	215	247	587	350	<1,759	2,071
SO_4	12,634	15,168	23,958	17,253	4,287	17,849
Sr	105	60	76	80	<352	0
TIC as CO_3	n/r	49,396	2.07E+05	128,214	10,667	29,178
TOC	3,874	3,356	7,708	4,979	3,284	7,007
U	311	220	908	480	<17,595	6,168
Zr	6	8	19	11	<352	2.98
Density (g/mL)	n/r	1.71	n/r	1.71	1.74	1.63
H_2O wt%	16.1	25.5	23.2	21.6	36.2	36.3
Radionuclides[6]	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g
^{137}Cs	n/r	148.3	81.6	115	n/r	145
^{90}Sr	n/r	n/r	30.0	30.0	n/r	122
$^{239/240}Pu$	n/r	n/r	0.0247	0.0247	n/r	0.1022

Notes:

[1]Less than values were not included in this analysis.
[2]Simpson et al. (1996b)
[3]Bell et al. (1996)
[4]Simpson et al. (1996a)
[5]Agnew et al. (1997a)
[6]Radionuclides are decayed to January 1, 1994.

The average composition, based on sample analyses, of core 197 compares within approximately a factor of two with the predicted BYSltCk composition for most major components from the HDW model. Two obvious outliers are the high chromium and phosphate results for core 197. The mean phosphate result for core 197 is triple the maximum result of any of the BYSltCk comparison tanks. However, this phosphate concentration is lower than that noted for BSltCk tanks in the following section. For core 198, no clear demarcation can be identified between segments representative of BYSltCk and those more representative of 1C sludge or BSltCk. The bismuth concentrations in all the core 198 samples in Table D3-2 are indicative of BSltCk and 1C sludge and are not typically associated with BYSltCk. Therefore, core 197 results and not core 198 results are used to assess the inventory of the BYSltCk layer. The average analytical-based composition from tanks 241-BY-105, 241-BY-106, and 241-BY-110 is used to estimate the inventory of the tank 241-BX-110 BYSltCk analytes where the analytical data indicate "less than" composition values.

D3.3.2 Basis for Assessing B Saltcake Inventories in Tank 241-BX-110

The abbreviation, BSltCk, is used by Agnew et al. (1997a) to represent salt waste supernatants that were evaporated and concentrated in the 242-B Evaporator until they were largely solidified. Tank 241-BX-110 received 242-B Evaporator bottoms, which are assumed to have formed a layer of BSltCk. Agnew et al. (1997a) assume that the BSltCk layer was washed out by subsequent transfers. However, a review of the waste transfer history (Agnew et al. 1997b) indicates that up to 87 kL (23 kgal) of BSltCk remained in the tank when additional salt-forming concentrates were received from the 241-BY ITS campaigns. The uppermost layer in tank 241-BX-110 is believed to consist of BYSltCk deposited above the BSltCk. It is conceivable that intermixing of the two saltcake waste types may have occurred if the hot ITS evaporator bottoms dissolved some of the BSltCk. This section compares data from core 198 to BSltCk. Agnew et al. (1997a) provides a single average composition for the BSltCk defined waste. However, historical records (Anderson 1990 and Agnew et al. 1997b) indicate that supernatants from the first-cycle bismuth phosphate process (1C waste) and supernatants from the uranium recovery process were evaporated in the 242-B Evaporator and transferred to several tanks in the 241-B Tank Farm. The chemical compositions of the dilute supernatants from these processes differed. Because the supernatants were not all blended together before evaporation, the saltcake compositions resulting from evaporation of these wastes are expected to differ as a function of position within a tank and as a function of which tank was used as a receiver at a particular time.

Because of the complicated waste supernatant transfer history of feed to the 242-B Evaporator and the lack of a flowsheet basis for the waste, it is difficult to perform an independent assessment to estimate the saltcake composition that can be compared to the model-based BSltCk composition. However, waste samples from a limited number of B Tank Farm tanks expected to contain BSltCk have been analyzed and reported. Table D3-4 summarizes the composition data for tanks 241-B-104 (Field and Higley 1997), 241-B-106 (Higley and Field

1997), 241-B-108 (Schreiber 1997), and 241-B-109 (Benar 1997a). The analytical results for these tanks were evaluated at the core segment level to identify the areas representing BSltCk. The mean of segments 2, upper half and lower half , segment 3, and segment 4 of core 198 from tank 241-BX-110 is also shown. The data for core 197 were shown previously in the assessment of the BYSltCk in Table D3-3. To provide a common basis for comparison of the data in Table D3-3, the reported water mass was removed from the results (i.e., the results are compared on a water-free basis). Table D3-3 includes the HDW model composition for BSltCk (also on a water-free basis) for comparison.

Comparing Tables D3-1 and D3-3 with the core sample results in Table D3-2, segments 1, 2, and 2A of core 197 resemble BYSltCk. Major differences between BSltCk and BYSltCk include higher concentrations of aluminum, bismuth, and phosphate in BSltCk. There is sufficient overlap in the aluminum concentrations in both saltcake waste types to span the ranges of aluminum concentration found in cores 197 and 198, except for core 198-4. The composition of core 198 agrees within a factor of two with the composition of BSltCk given in Table D3-4. The demarcation point between the three postulated layers is not apparent by inspection of the data. Consequently, the mean of segments 2, upper half and lower half; segment 3, and segment 4 of core 198 will be used to assess the composition of the BSltCk layer. Mean analytical results given in Table D3-4 for the comparison tanks will be used where available to fill in the gaps in the Tank 241-BX-110 core sample results.

Table D3-4. Composition of 242-B Evaporator Saltcake in Tank 241-BX-110 (Water-Free Basis). (2 sheets)

Analyte	B-104[1]	B-106[2]	B-108[3]	B-109[4]	Mean	BX-110 C198 Mean	HDW Model[5] BSltCk
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Al	3,471	6,925	40,400	40,380	22,794	57,559	432
Bi	21,516	7,238	<3,130	6,808	11,854	9,530	3,818
Ca	618	4,499	<3,020	<2,950	2,559	<3,380	2,894
Cr	966	666	355	1,420	852	4,245	290
Fe	19,857	35,011	<1,570	5,908	20,259	5,348	6,666
K	n/r	315	1,900	n/r	1,108	n/r	599
La	n/r	<73	<1,570	<1,475	<1040	<1,694	0
Mn	n/r	403	<302	<295	403	<338	0
Na	2.21E+05	2.28E+05	3.44E+05	4.17E+05	3.02E+05	3.75E+05	2.95E+05
Ni	n/r	129	n/r	n/r	129	n/r	500
Pb	n/r	741	<3,020	<3,023	741	<3,380	0

Table D3-4. Composition of 242-B Evaporator Saltcake in Tank 241-BX-110 (Water-Free Basis). (2 sheets)

Analyte	B-104[1]	B-106[2]	B-108[3]	B-109[4]	Mean	BX-110 C198 Mean	HDW Model[5] BSltCk
Si	10,729	4,092	2,051	2,236	4,777	3,315	1,170
Sr	n/r	911	<302	<295	911	<338	0
U	3,616	27,821	1,930	<14,750	11,122	<16,939	15,900
Zr	n/r	<73	<302	<295	<223	<338	13.9
CO_3	n/r	1,625	6,925	n/r	4,275	5,775	11,480
Cl	3,974	3,334	1,471	1,495	2,569	1,890	3,030
F	6,516	5,632	61,280	79,614	38,261	13,654	1,979
NO_3	546,139	409,639	114,590	219,962	322,583	543,112	547,100
NO_2	4,614	16,044	19,275	7,907	11,960	14,789	11,150
PO_4	43,879	66,436	1.82E+05	1.26E+05	1.05E+05	81,634	95,690
SO_4	41,153	31,312	1.84E+05	3.17E+05	1.43E+05	20,546	12,770
Radio-nuclides	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g
^{137}Cs	n/r	53.3	25.2	n/r	39.2	n/r	49.0
^{90}Sr	n/r	157.5	3.5	n/r	80.5	n/r	12.5

Notes:

n/r = not reported

[1]Field and Higley (1997)

[2]Higley and Field (1997)

[3]Schreiber (1997). Data from upper half of segment 1 from cores 172 and 173 are not included because these partial segments contain primarily CW.

[4]Benar (1997a). Core 170. Core 169 data are not shown because this core contained primarily CW.

[5]Agnew et al. (1997a)

[6]Radionuclides decayed to January 1, 1994.

D3.4 ESTIMATED CHEMICAL INVENTORY FOR TANK 241-BX-110

The estimated chemical inventory for tank 241-BX-110 is the sum of the individual inventories of the 1C sludge, BYSltCk, BSltCk, and supernatant components for all analytes except mercury and hydroxide. The mercury inventory of each tank was established by a global inventory reconciliation for all waste tanks (Simpson 1998). The hydroxide inventory was computed by a charge balance of the entire tank contents after summation of the contributions of the individual layers. The individual inventories of the 1C, BYSltCk, BSltCk, and supernatant layers are presented in Tables D3-8, D3-9, D3-10, and D3-11, respectively. Table D3-12 contains the combined chemical inventory for the entire tank. Table D3-12 also includes a sample-based inventory and the inventory estimated by the HDW model for the tank (Agnew et al. 1997a) for comparison.

D3.4.1 Inventory of 1C Waste

The estimated inventory for the 1C waste components for tank 241-BX-110 was calculated as the product of the 1978 core sample component concentrations on a dry weight basis; a waste volume of 503 kL (133 kgal); the average density of 1.87 for core 198, segment 3, lower half and segment 4, lower half; and the average water content of 38.2 percent for core 198, segments 3 and 4. Gaps in the 1978 core sample data were filled in using the average 1C sludge concentrations given in Table D3-1 where available and with HDW compositions where no other analytical data were available. The 1978 core sample results for bismuth, fluoride, silicon, and uranium diverged greatly from both the average 1C sludge concentrations given in Table D3-1 and the HDW model concentrations. Consequently, the 1C sludge concentration was used for these analytes. Because the core samples from core 198 appeared to contain a combination of sludge and saltcake, the core 198 analytical results were not used to calculate the 1C sludge component inventory. The inventory of 1C waste is summarized in Table D3-5.

Table D3-5. Inventory of 1C Waste in Tank 241-BX-110. (2 sheets)

		Comments
kgal	133	
kL	503	
Density, g/cm^3	1.875	Core 198, segments 3 and 4
kg	9.43E+05	Product of volume and density
% Water	38.2	Core 198, segments 3 and 4

Table D3-5. Inventory of 1C Waste in Tank 241-BX-110. (2 sheets)

Analyte	Concentration		Inventory	Comments
	μg/g dry	μg/g wet	kg	
Al	38,254	23,641	22,296	1978 core sample[1]
Bi	44,292	27,372	25,816	Average 1C composition in other tanks[1]
Ca	3,894	2,406	2,270	Average 1C composition in other tanks[1]
Cl	2,341	1,447	1,364	Average 1C composition in other tanks[1]
TIC as CO_3	24,224	14,970	14,119	Average 1C composition in other tanks[1]
Cr	2,723	1,683	1,587	1978 core sample[1]
F	24,273	15,001	14,148	Average 1C composition in other tanks[1]
Fe	33,799	20,888	19,700	Average 1C composition in other tanks[1]
Hg	41	25	24	Global reconciliation for entire tank
K	705	436	411	Average 1C composition in other tanks[1]
La	314	194	183	1978 core sample[1]
Mn	352	218	205	Average 1C composition in other tanks[1]
Na	2.74E+05	1.79E+05	1.60E+05	1978 core sample[1]
NO_2	31,924	19,729	18,607	Average 1C composition in other tanks[1]
NO_3	2.91E+05	1.80E+05	1.70E+05	1978 core sample[1]
OH_{TOTAL}	--	--	--	Charge balance for entire tank
Pb	611	378	356	Average 1C composition in other tanks[1]
Si	18,210	11,254	10,614	Average 1C composition in other tanks[1]
SO_4 (IC)	11,975	7,401	6,980	1978 core sample[1]
TOC	1,599	988	932	1978 core sample[1]
U_{TOTAL}	12,994	8,030	7,574	Average 1C composition in other tanks[1]
Zr	301	186	175	Average 1C composition in other tanks[1]

Note:
[1]Adjusted for density of 1.87 g/cm^3 and 38.2 percent moisture content to agree with physical properties of core 198, segments 3 and 4.

D3.4.2 Inventory of BSltCk Waste

The estimated chemical inventory for the BSltCk waste was calculated as the product of the average component concentrations for core 198 given in Table D3-4, a waste volume of 87 kL (23 kgal), the average density of 1.83 for core 198, and the average water content of

36.3 percent for core 198. Gaps in the data were filled in using the average component concentrations for BSltCk from Table D3-4 where available and HDW composition from Table D3-4. Table D3-6 shows the BSltCk waste inventory of tank 241-BX-110.

Table D3-6. Inventory of Tank 241-BX-110 B Salt Cake Layer. (2 sheets)

				Comments
kgal	23			
kL	87			
Density, g/cm^3	1.83			Core 198 mean
kg	1.59E+05			Product of volume and density
% Water	36.3			Core 198 mean
	Concentration		Inventory	
Analyte	μg/g dry	μg/g wet	kg	Comments
Al	57,559	36,679	5,824	Core 198 mean result[1]
Bi	9,530	6,073	964	Core 198 mean
Ca	2,559	1,630	259	Average BSltCk composition in other tanks
Cl	1,890	1,204	191	Core 198 mean[1]
TIC as CO_3	5,755	3,680	584	Core 198 mean[1]
Cr	4,245	2,705	429	Core 198 mean[1]
F	13,654	8,701	1,381	Core 198 mean[1]
Fe	5,348	3,408	541	Core 198 mean[1]
Hg	2	2	0	Global reconciliation for entire tank
K	1,108	706	112	Average BSltCk composition in other tanks[1]
La	0	0	0	HDW model[1]
Mn	403	257	41	Average BSltCk composition in other tanks[1]
Na	3.75E+05	2.39E+05	37,944	Core 198 mean[1]
Ni	129	82	13	Average BSltCk composition in other tanks[1]
NO_2	14,789	9,424	1,496	Core 198 mean[1]
NO_3	5.43	3.46E+05	54,952	Core 198 mean[1]
Pb	741	472	75	Average BSltCk composition in other tanks[1]

Table D3-6. Inventory of Tank 241-BX-110 B Salt Cake Layer. (2 sheets)

Analyte	Concentration µg/g dry	Concentration µg/g wet	Inventory kg	Comments
PO_4 (ICP)	81,634	52,021	8,260	Core 198 mean[1]
Si	3,315	2,113	335	Core 198 mean[1]
SO_4 (IC)	20,546	13,093	2,079	Core 198 mean[1]
Sr	911	581	92	Average BSltCk composition in other tanks[1]
TOC	1,686	1,074	171	Core 198 mean[1]
U_{TOTAL}	11,122	7,088	1,125	Average BSltCk composition in other tanks[1]
Zr	14	9	1	Average BSltCk composition in other tanks[1]

Note:

[1]Adjusted for density of 1.83 g/cm^3 and 38.3 percent moisture content to agree with physical properties of core 198, segment 2, upper half and lower half, segment 3, and segment 4.

D3.4.3 Inventory of BYSltCk Waste

The estimated inventory for BYSltCk waste was calculated as the product of the average component concentrations for the segments 1, 2, and 3 of core 197 from Table D3-3; a waste volume of 159 kL (42 kgal); and the average density of 1.74 g/mL for core 197, segments 1, 2, and 2A. Gaps in the data for tank 241-BX-110 were filled in using the average composition, on a dry weight basis, of the other tanks listed in Table D3-3 and adjusted to account for the 36.2 percent average moisture content of core 197, segments 1, 2, and 2A. If sample results were below detection limits, then the HDW concentration was used. Table D3-7 summarizes the BYSltCk inventory of tank 241-BX-110.

D3.4.4 Inventory of Supernatant

The estimated inventory of the supernatant layer was calculated as the product of the average drainable liquid composition of core 197, segment 1 and core 198, segment 1 from Appendix B; the average drainable liquid density of 1.60 g/mL for core 197, segment 1, and core 198, segment 1; and a supernatant volume of 11 kL (3 kgal). There is no attempt made to estimate the contribution of analytes below the detection limit because of the small total contribution of the supernatant to the overall tank inventory. The supernatant inventory is shown in Table D3-8.

Table D3-7. BYSltCk Inventory of Tank 241-BX-110. (2 sheets)

				Comments
kgal	42			
kL	159			
Density, g/cm^3	1.74			Core 197 mean
kg	2.76E+05			
% Water	36.2			Core 197 mean
	Concentration		Inventory	
Analyte	μg/g dry	μg/g wet	(kg)	Comments
Al	15,250	9,734	2,688	Core 1997 mean[1]
Bi	66	42	12	Average BYSltCk in other tanks[1]
Ca	397	254	70	Average BSltCk composition in other tanks[1]
Cl	2,698	1,722	476	Core 197 mean[1]
TIC as CO_3	10,667	6,809	1,880	Core 197 mean[1]
Cr	19,390	12,377	3,418	Core 197 mean[1]
F	6,042	3,857	1,065	Core 197 mean[1]
Fe	686	438	121	Average BSltCk composition in other tanks[1]
Hg	7	5	1	Global reconciliation for entire tank
K	2,226	1,421	392	Average BSltCk composition in other tanks[1]
La	0	0	0	HDW model[1]
Mn	49	31	9	Average BSltCk composition in other tanks[1]
Na	3.64E+05	2.32E+05	64,109	Core 197 mean[1]
Ni	135	86	24	Average BSltCk composition in other tanks[1]
NO_2	20,634	13,172	3,637	Core 197 mean[1]
NO_3	6.52E+05	4.16E+05	1.15E+05	Core 197 mean[1]
Pb	105	67	19	Average BSltCk composition in other tanks[1]
PO_4 (ICP)	58,933	37,619	10,388	Core 197 mean[1]
SO_4 (IC)	4,287	2,736	756	Core 197 mean[1]

Table D3-7. BYSltCk Inventory of Tank 241-BX-110. (2 sheets)

Analyte	Concentration		Inventory (kg)	Comments
	µg/g dry	µg/g wet		
Sr	80	51	14	Average BSltCk composition in other tanks[1]
U_{TOTAL}	480	306	85	Average BSltCk composition in other tanks[1]
Zr	11	7	2	Average BSltCk composition in other tanks[1]

Note:

[1]Adjusted for density of 1.74 g/cm^3 and 36.2 percent moisture content to agree with physical properties of core 197, segments 1, 2A, and 2B.

Table D3-8. Supernatant Inventory for Tank 241-BX-110. (2 sheets)

			Comments
kL	11		
Density, g/cm^3	1.60		Mean of C197-1 and C-198-1 drainable liquid
kg	18,168		Product of volume and density
% Water	52.8		Mean of C197-1 and C-198-1 drainable liquid
Analyte	Sample µg/mL	Inventory kg	Comments
Al	4,945	56	Mean of C197-1 and C-198-1 Drainable Liquid
Bi	340	4	Mean of C197-1 and C-198-1 drainable liquid
Ca	49	1	Mean of C197-1 and C-198-1 drainable liquid
Cl	3,843	44	Mean of C197-1 and C-198-1 drainable liquid
TIC as CO_3	0	0	Not reported
Cr	5,500	62	Mean of C197-1 and C-198-1 drainable liquid
F	1,113	13	Mean of C197-1 and C-198-1 drainable liquid
Hg	0	0	Not reported
K	2,957	34	Mean of C197-1 and C-198-1 drainable liquid
La	0	0	Not detected
Mn	0	0	Not detected

Table D3-8. Supernatant Inventory for Tank 241-BX-110. (2 sheets).

Analyte	Sample $\mu g/mL$	Inventory kg	Comments
Na	221,000	2,509	Mean of C197-1 and C-198-1 drainable liquid
Ni	26	0	Mean of C197-1 and C-198-1 drainable liquid
NO_2	35,667	405	Mean of C197-1 and C-198-1 drainable liquid
NO_3	746,333	8,475	Mean of C197-1 and C-198-1 drainable liquid
Pb	159	2	Mean of C197-1 and C-198-1 drainable liquid
PO_4 (ICP)	1,477	17	Mean of C197-1 and C-198-1 drainable liquid
Si	122	1	Mean of C197-1 and C-198-1 drainable liquid
SO_4 (IC)	2,353	27	Mean of C197-1 and C-198-1 drainable liquid
Sr	3	0	Mean of C197-1 and C-198-1 drainable liquid
TOC	0	0	Not reported
U_{TOTAL}	0	0	Not detected
Zr	3	0	Mean of C197-1 and C-198-1 drainable liquid

D3.4.5 Sample-Based Inventory

To compare the HDW model and engineering inventory estimates with the 1997 core sample data, the inventory of tank 241-BX-110 is also evaluated purely from sampling data without consideration of the contributing waste types, flowsheets, or transfer history. Such a sample-based inventory is of interest for comparison only and is not sufficient to fully characterize the tank because the sample data set includes very limited radionuclide analyses. This sample-based inventory estimate takes into account the complex sampling evolution that resulted in each sample result representing a differing quantity of tank contents. The sample results are weighted to eliminate the spatial bias in the mean analytical results in section B3-4. Five samples (core 197, sections 1, 2, and 2A, and core 198, sections 2, upper half and lower half) were obtained from the upper 66 cm (26 in.) of solids, while only two samples (core 198k sections 3 and 4) were obtained from the lower 107 cm (42 in.) of waste. The spatial weighting consists of multiplying the mean analyte concentration result for each solid segment or subsegment by the volume of tank waste represented by that sample. The mean density result for each sample result was used. The sample-based inventory then is the summation of these individual quantities.

The core sampling worksheets and data sheets were reviewed to determine the volume of tank contents represented by each sample. The tank was assumed to be stratified vertically and homogenous horizontally. In the upper portion of the tank for which core sample segments were recovered from both risers 3 and 6, the analytical result from each riser was weighted equally. For the lower portion of the tank for which sample segments were recovered from only riser 3, those analytical results were considered to represent the entire cross section at that depth.

Table D3-9 shows the volume associated with each sample. Each sample segment is assumed to represent a cylindrical section of the tank waste equal in height to the sampler stroke length. This is appropriate because it is not known from which portion or portions of the sampler stroke the solids were collected. The sectional fraction equals 1 if that sample segment is the only sample representing that section of the tank. For those portions of the tank where samples were recovered from both risers 3 and 6, the sectional fraction equals 50 percent, thereby giving equal weight to each sample result for that area. For core 198, segment 2, each of the two subsamples was assumed to represent half of the 48-cm (19-in.) sampler stroke. Core 197, segment 2A overlapped part of the lower half of core 198-2. Therefore, the sectional fraction of the lower half of core 198, segment 2 was adjusted to reflect that the top 10.8 cm (4.25 in.) thereof overlapped core 197, segment 2A, while the bottom 13.5 cm (5.2 in.) was the only sample of that elevation of the tank. Core 198, segment 4 was assumed to represent not only the 33-cm (13-in.) stroke, but also all waste below that level, including the 7.6-cm (3-in.) bit set, the 7.6-cm (3-in.) tank bottom safety margin, and the 21.1-cm (8.3-in.) difference between the elevation of the tank bottom beneath the riser and the bottom center of the tank. The waste surface zip cord measurement used to establish the sampler stroke lengths agreed closely with the volume of the main solid waste mass in Hanlon (1998). The RPD was only 0.21 percent. The uppermost saltcake sample, segment 1 of core 197, is assumed to most closely represent the composition of the shelf. The volume of the shelf, adjusted slightly to bring the total represented volume into agreement with the Hanlon (1998) volume, is added to the volume represented by segment 1 of core 197.

The composition of each sample segment is obtained from the mean sample results given in Appendix B. Table D3-10 summarizes these analytical results on a segment-by-segment basis for each analyte. The sample-based inventory is presented in Table D3-11. The mass of each analyte is the product of the analytical concentration and the volume represented by the corresponding sample segment.

Table D3-9. Volumes Represented By Individual Sample Segments/Subsegments Obtained from Tank 241-BX-110 in 1997.

Segment	C197-1	C197-2	C197-2A	C198-2	C198-2	C198-3	C198-4
Subsegment	LH	LH	LH	UH	LH	LH	LH
Stroke, in.	7.58	6	7.75	9.5[1]	9.5[1]	19	13
Represented in.	7.58	6	7.75	9.5	9.5	19	33.3
Sectional fraction	1	0.5	0.5	0.5	0.776[2]	1	1
Volume, L	78,898	31,226	40,334	49,442	76,765	1.98E+05	2.68E+05[3]
Less supernatant, L	11,000						
Solids volume, L	67,898	31,226	40,334	49,442	76,765	1.99E+05	2.69E+05
Total solid segment represented volume, L				7.32E+05			
Solid volume per Hanlon (1998), L				7.72E+05			
Less volume of shelf, L				38,429			
Volume of main waste mass per Hanlon (1998), L				733,571			
Waste volume agreement for main waste mass, percent RPD				0.21			
Shelf adjustment	39,967[4]	0	0	0	0	0	0
Adjusted volume, L	1.08E+05	31,226	40,334	49,442	76,765	1.98E+05	2.69E+05

Notes:

[1]Core 182, segment 2, stroke was 48 cm (19 in.). Lower half and upper half subsegments were each assumed to represent half of the sampler stroke.

[2]Core 197, segment 2A overlaps top 10.8 cm (4.25 in.) of the lower half of core 198, segment 2. Sectional fraction for core 182, segment 2, lower half, then becomes: [(4.25/2) + (9.5-4.25)] / 9.5 = 0.78.

[3]Core 194, segment 4 represents the 33-cm (13- in.) stroke, plus the remaining 16.5 cm (6.5 in.) that were not sampled because of the bottom detector tripping, plus the 7.6-cm (3-in.) core bit set, plus the 7.6-cm (3-in.) tank bottom safety margin, plus the 21-cm (8.268-in.) elevation of tank bottom at riser 3 above the bottom center of the dished tank bottom.

[4]Composition of the shelf is best represented by uppermost saltcake sample (core 197, segment 1). Shelf volume was adjusted to bring total solids volume into agreement with Hanlon (1998).

Table D3-10. Mean Sample Results for Tank 241-BX-110 Core Sample Segments. (2 sheets)

Segment	C197-1	C197-2	C197-2A	C198-2	C198-2	C198-3	C198-4
Sub-segment	LH	LH	LH	UH	LH	LH	LH
Analyte	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g
Al	13,500	9,390	1,720	28,100	16,000	30,500	65,700
Bi	<2,130	<2,120	<2,140	7,480	2,810	3,150	9,630
Ca	<2,130	<2,120	<2,140	<2,120	<2,160	<2,110	<2,150
Cl	2,210	1,460	932	1,270	1,130	1,090	1,260
TIC as CO_3	8,800	5,100	4,670	5,050	4,370	2,990	2,270
Cr	22,800	6,990	805	5,250	2,190	1,930	1,200
F	4,650	4,350	828	11,000	6,930	4,990	10,800
Fe	<1,060	<1,060	<1,070	5,690	1,390	1,660	4,180
Hg	n/r	n/r	n/r	n/r	n/r	n/r	n/r
K	n/r	n/r	n/r	n/r	n/r	n/r	n/r
La	<1,060	<1,060	<1,070	<1,060	<1,080	<1,060	<1,080
Mn	<213	<212	<214	<212	<216	<211	<215
Na	1.75E+05	2.37E+05	2.66E+05	2.18E+05	2.71E+05	2.51E+05	2.16E+05
Ni	n/r	n/r	n/r	n/r	n/r	n/r	n/r
NO_2	17,700	10,400	7,030	10,500	8,220	8,950	9,430
NO_3	2.30E+05	4.25E+05	6.18E+05	2.25E+05	4.69E+05	4.59E+05	2.58E+05
OH_{TOTAL}	n/r	n/r	n/r	n/r	n/r	n/r	n/r
Pb	<2,131	<2,120	<2,140	<2,120	<2,160	<2,110	<2,150
PO_4 (ICP)	38,863	43,577	17,074	68,552	52,752	33,766	49,439
PO_4 (IC)	44,900	38,400	12,200	66,600	53,900	33,000	68,000
Si	<1,060	<1,060	<1,070	2,270	1,490	1,360	3,040
SO_4 (ICP)	<6,390	<6,360	<6,420	19,290	7,290	9,570	14,250
SO_4 (IC)	3,150	2,470	1,840	15,900	6,970	7,930	12,600
Sr	<213	<212	<214	<212	<216	<211	<215
TOC	2,770	1,770	1,010	2,210	1,100	590	326
U_{TOTAL}	<10,600	<10,600	<10,700	<10,600	<10,800	<10,600	<10,800
Zr	<213	<212	<214	<212	<216	<211	<215

Table D3-10. Mean Sample Results for Tank 241-BX-110 Core Sample Segments. (2 sheets)

Segment	C197-1	C197-2	C197-2A	C198-2	C198-2	C198-3	C198-4
Sub-segment	LH	LH	LH	UH	LH	LH	LH
Analyte	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g
% H_2O	48.3	46.8	13.4	41.4	27.3	34	42.4
Density, g/cm^3	1.54	1.78	1.89	1.72	1.83	1.88	1.87
Total alpha, μCi/g	0.00477	<0.00291	<0.00175	n/r	0.00996	0.0116	0.0218

Table D3-11. Spatially Weighted Sample-Based Inventory for Tank 241-BX-110. (2 sheets)

Segment	C197-1	C197-2	C197-2A	C198-2	C198-2	C198-3	C198-4	Total
Sub-segment	LH	LH	LH	UH	LH	LH	LH	
Liters	1.08E+05	31,226	40,334	49,442	76,765	1.98E+05	2.69E+05	7.72E+05
Analyte	kg	kg	kg	kg	kg	kg	kg	kg
Al	2,243	522	131	2,390	2,248	11,340	33,000	51,873
Bi	<354	<118	<163	636	395	1,171	4,837	7,039
Ca	<354	<118	<163	<180	<303	<784	<1,080	<2,982
Cl	367	81	71	108	159	405	633	1,824
TIC as CO_3	1,462	283	356	429	614	1,112	1,140	5,396
Cr	3,787	389	61	446	308	718	603	6,312
F	772	242	63	935	974	1,855	5,425	10,266
Fe	<176	<59	<82	484	195	617	2,100	3,396
Hg	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r
K	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r
La	<176	<59	<82	<90	<152	<394	<542	<1,495
Mn	<35	<12	<16	<18	<30	<78	<108	<297
Na	29,070	13,173	20,277	18,539	38,070	93,322	1.08E+05	3.20E+05
Ni	n/r	n/r	n/r	n/r	n/r	n/r	n/r	n/r
NO_2	2,940	578	536	893	1,155	3,328	4,737	14,166

Table D3-11. Spatially Weighted Sample-Based Inventory for Tank 241-BX-110. (2 sheets)

Segment	C197-1	C197-2	C197-2A	C198-2	C198-2	C198-3	C198-4	Total
Sub-segment	LH	LH	LH	UH	LH	LH	LH	
Analyte (Cont'd)	kg	kg	kg	kg	kg	kg	kg	kg
NO_3	38,206	23,623	47,111	19,134	65,885	1.71E+05	1.30E+05	4.94E+05
OH_{TOTAL}	0	C	0	0	0	0	0	n/r
Pb	<354	<118	<163	<180	<303	<784	<1080	<2,982
PO_4 (ICP)	6,456	2,422	1,302	5,830	7,410	12,554	24,832	60,806
PO_4 (IC)	7,458	2,134	930	5,664	7,572	12,269	34,155	
Si	<176	<59	<82	193	209	506	1,527	2,435
SO_4 (ICP)	<1061	<354	<489	1,640	1,024	3,558	7,158	14,181
SO_4 (IC)	523	137	140	1,352	979	2,948	6,329	
Sr	<35	<12	<16	<18	<30	<78	<108	<297
TOC	460	98	77	188	155	219	164	1,361
U_{TOTAL}	<1761	<589	<816	<901	<1,517	<3,941	<5,425	<14,950
Zr	<35	<12	<16	<18	<30	<78	<108	<297
% water	80,232	26,013	10,215	35,206	38,351	1.26E+05	2.13E+05	33.1
Density, g/cm^3	1.54	1.78	1.89	1.72	1.83	1.88	1.87	1.81
Total alpha, Ci	0.000792	<0.000162	<0.0001	n/r	0.00140	0.00431	0.01095	0.0175

D3.4.6 Summation of Chemical Component Inventory Estimates

Table D3-12 shows the summation of the individual layer-by-layer inventory estimates. For comparison, the sample-based inventory and the HDW inventory are presented, as well. Comparison of the inventory estimates indicates that the estimated chemical inventory for most analytes is higher than the HDW inventory. This is consistent with the higher density noted in the 1997 core samples and the assumption that the tank contains more saltcake, including BSltCk, and less 1C than the HDW model predicts. The sample-based inventory has more aluminum, sodium, and nitrate, and less bismuth and phosphate than the layer-by-layer component inventory which takes into account the fill history of the tank. This results to a large extent from the incorporation of 1978 core sample data to estimate the composition of the 1C waste layer.

Table D3-12. Estimated Chemical Inventory for Tank 241-BX-110.[1]

Analyte	1C	BSltCk	BYSltCk	Supernatant	Sum of Layers	HDW Model[2]	Sample Based
Al	22,296	5,824	2,688	56	30,864	16,900	51,873
Bi	25,816	964	12	4	26,795	7,540	7,039
Ca	2,270	259	70	1	2,599	2,230	<2,982
Cl	1,364	191	476	44	2,075	1,400	1,824
TIC as CO_3	14,119	584	1,880	0	16,600	7,460	5,396
Cr	1,587	429	3,418	62	5,497	606	6,312
F	14,148	1,381	1,065	13	16,607	1,750	10,266
Fe	19,700	541	121	0	20,362	11,500	3,396
Hg	24	0	1	0	26	12.8	n/r
K	411	112	392	34	949	406	n/r
La	183	0	0	0	183	0.0452	<1,495
Mn	205	41	9	0	255	28.3	<297
Na	1.60E+05	37,944	64,109	2,509	2.64E+05	1.17E+05	3.21E+05
Ni	118	13	24	0	156	168	n/r
NO_2	18,607	1,496	3,637	405	24,145	19,700	14,166
NO_3	1.70E+05	54,952	1.15E+05	8,475	3.48E+05	1.01E+05	4.94E+05
OH_{TOTAL}	--	--	--	--	58,181[3]	63,200	n/r
Pb	356	75	19	2	452	187	<2,982
PO_4	142,138	8,260	10,388	17	160,802	64,100	60,806
Si	10,614	335	62	1	11,012	3,460	2,435
SO_4	6,980	2,079	756	27	9,841	5,940	14,181
Sr	375	92	14	0	482	0	<297
TOC	932	171	579	0	1,681	1,160	1,361
U_{TOTAL}	7,574	1,125	85	0	8,783	28,100	<14,950
Zr	175	1	2	0	179	13.6	<297

Notes:

[1]All data are in kilograms.

[2]Agnew et al. (1997a)

[3]Charge balance

D3.5 ESTIMATED RADIONUCLIDE INVENTORY FOR TANK 241-BX-110

The radionuclide inventory estimate for tank 241-BX-110 uses sample results where available but must rely primarily on HDW model predictions for the waste types assumed to be present in the tank, since few radionuclide analyses of tank 241-BX-110 have been performed. The 1997 core samples from tank 241-BX-110 were analyzed for total alpha activity, but not for individual radionuclides. Uranium was not detected in any of the 1997 core samples because of the high detection limits associated with the KOH fusion ICP sample preparation technique. The 1978 core sample was analyzed for uranium, plutonium, ^{137}Cs, and $^{89/90}$Sr. Uranium, ^{137}Cs, and $^{89/90}$Sr results are available for other tanks containing the waste types predicted to be in tank 241-BX-110. The concentrations of ^{137m}Ba and ^{90}Y are inferred assuming secular equilibrium with ^{137}Cs and ^{90}Sr. The concentrations of alpha emitting isotopes is estimated by normalization of HDW model isotopic distributions to agree with measured U, Pu, and total alpha results. The HDW model prediction in the best basis for estimating the inventories of all other radionuclides.

D3.5.1 Radionuclide Inventory of 1C Waste Layer

Available sample results for the 1C waste layer include uranium, plutonium, ^{137}Cs, and $^{89/90}$Sr from the 1978 core sample event. The radionuclide concentrations were computed on a dry weight basis. The concentrations were then adjusted for the mean water content and density of core 198, segments 3 and 4. The inventory of each radionuclide is then the product of the volume of the waste layer and the adjusted radionuclide concentration. For ^{137}Cs and $^{89/90}$Sr, the starting point was the concentration of those radionuclides in the 1978 core sample. The concentrations of ^{137m}Ba and ^{90}Y are inferred assuming secular equilibrium with ^{137}Cs and ^{90}Sr. For uranium and plutonium, the isotopic distribution in the HDW model for the 1C1 and 1C2 waste blend was normalized for the concentrations found in the 1978 core samples. The 1978 core sample water soluble plutonium result was not used in the radionuclide inventory assessment. Plutonium is not expected to be appreciably water soluble in the 1C sludge matrix. Only the water-insoluble plutonium result was used in the inventory calculation. Table D3-10 shows the radionuclide inventory for these isotopes.

The alpha normalization factors for uranium and plutonium differed widely. The alpha normalization factor for uranium is 0.112 to reduce HDW radionuclide concentrations to agree with the mean sample result for 1C waste in other tanks. The alpha normalization factor for plutonium, on the other hand, is 3.16 to increase the HDW plutonium concentrations to the 4.43 μg/g dry weight concentration in the 1978 core sample result. Because the uranium and plutonium alpha normalization factors differ by an order of magnitude, no further alpha normalization was performed for other alpha-emitting isotopes in the 1C layer.

Table D3-13. Radionuclide Inventory of 1C Waste. (2 sheets)

				Comments
kgal	133			
kL	503			
Density, g/cm³	1.875			Mean of core 198, segments 3 and 4
kg	9.43E+05			
% Water	38.2			Mean of core 198, segments 3 and 4
	Concentration		Inventory	
Radionuclide[3]	μCi/g dry	μCi/g wet	Ci	Comments
^{90}Sr	11.4	7.02	6,625	1978 core sample[2]
^{90}Y	11.4	7.02	6,625	Assume secular equilibrium with ^{90}Sr.
^{137m}Ba	67.3	41.6	39,218	Assume secular equilibrium with ^{137}Cs
^{137}Cs	71.1	44.0	41,456	1978 core sample[2]
^{232}U	6.81E-08	4.21E-08	3.97E-05	Uranium normalization[2]
^{233}U	3.35E-09	2.07E-09	1.95E-06	Uranium normalization[2]
^{234}U	0.00404	0.0025	2.35	Uranium normalization[2]
^{235}U	1.37E-04	8.45E-05	0.0797	Uranium normalization[2]
^{236}U	3.07E-05	1.90E-05	0.0179	Uranium normalization[2]
^{238}Pu	0.00195	0.00121	1.14	Plutonium normalization
^{238}U	0.00435	0.00269	2.53	Uranium normalization
^{239}Pu	0.268	0.166	156	Plutonium normalization
^{241}Am	4.95E-04	3.06E-04	0.289	HDW model 1C1/1C2[1,2]
^{240}Pu	0.025	0.015	14.3	HDW model 1C1/1C2[1,2]
^{241}Pu	0.081	0.050	47.5	Plutonium normalization
^{242}Cm	1.40E-06	8.64E-07	8.15E-04	HDW model 1C1/1C2[1,2]
^{242}Pu	3.69E-07	2.28E-07	2.15E-04	Plutonium normalization
^{243}Am	3.47E-09	2.14E-09	2.02E-06	HDW model 1C1/1C2[1,2]
^{243}Cm	2.86E-08	1.77E-08	1.67E-05	HDW model 1C1/1C2[1,2]
^{244}Cm	8.23E-08	5.08E-08	4.79E-05	HDW model 1C1/1C2[1,2]

Notes:

[1]Blend of 38.6 percent 1C1 and 61.4 percent 1C2 defined waste (Agnew et al. 1997a)

[2]Adjusted for density and water content of core 198, segments 3 and 4.

[3]All radionuclides decayed to January 1, 1994.

D3.5.2 Radionuclide Inventory of BSltCk Waste Layer

Available sample results for the BSltCk waste layer include total alpha for the core 198 samples. Uranium, ^{137}Cs, and $^{89/90}Sr$ results are available for other tanks containing the same waste type. The ^{137}Cs and $^{89/90}Sr$ concentrations are obtained from other wastes containing BSltCk as shown in Table D3-4. The concentrations of ^{137m}Ba and ^{90}Y are inferred assuming secular equilibrium with ^{137}Cs and ^{90}Sr. Uranium, plutonium, americium, and curium isotopes are estimated by the alpha normalization of the uranium sample results for other tanks containing BYSltCk and the total alpha results for core 198. The remainder of the radionuclide concentrations are obtained from the HDW model composition for BSltCk. The concentrations are then adjusted for the water content of core 198, segments 2, 3 upper half and lower half, and 4. The inventory of each radionuclide then is the product of the volume of the waste layer, the radionuclide concentration, and the density. Table D3-16 shows the resulting BSltCk radionuclide inventory, for these isotopes.

In Table D3-14, the HDW uranium isotopic distribution for BSltCk is normalized to agree with the average BSltCk uranium concentration in other tanks containing the same waste type, as show in Table D3-4.

Table D3-14. Normalization of BSltCk Uranium Concentrations in Tank 241-BX-110.

Total Uranium (μg/g)		7,088	From Table D3-6	
		HDW Values	Computed (HDW/Specific Activity)	Adjusted (Ci/g * Normalization Factor)
Isotope	Specific Activity (Ci/g)	μCi/g	μg/g	μCi/g
^{232}U	21.4	1.10E-07	5.16E-09	4.93E-08
^{233}U	0.00968	5.36E-09	5.53E-07	2.39E-09
^{234}U	0.00625	0.00522	0.836	0.00233
^{235}U	2.16E-06	2.34E-04	108.45	1.05E-04
^{236}U	6.47E-05	4.85E-05	0.750	2.16E-05
^{238}U	3.36E-07	0.00531	15,784.75	0.00237
Total			15,894.79	0.00482
Normalization factor			0.446	

The remaining alpha isotopes are estimated by subtracting the total uranium activity in Table D3-14 from the mean total alpha activity for core 198 in Table D3-2. The difference, on a dry weight basis, is .0182 μCi/g. The HDW activity of plutonium, americium, and curium isotopes in BSltCk is normalized in Table D3-15 to agree with this non-uranium net alpha activity. Table D3-16 shows the BSltCk radionuclide inventory.

Table D3-15. Normalization of Non-Uranium Alpha Contributors for Tank 241-BX-110 BSltCk Layer, Dry Weight Basis.

Alpha Contributor	HDW Model BSltCk Concentration[1] (μCi/g)	Adjusted Concentration[2] (μCi/g)
U_{TOTAL}[3]	0.00482	
Total alpha	0.0230	
Net alpha (non-uranium)	0.0182	
^{238}Pu	2.68E-04	9.01E-05
^{239}Pu	0.0491	0.0165
^{240}Pu	0.00382	0.00128
^{241}Pu[4]	0.00941	0.00189
^{242}Pu	4.19E-08	1.41E-08
^{241}Am	9.37E-04	3.15E-04
^{243}Am	6.53E-09	2.21E-09
^{242}Cm	1.41E-06	4.73E-07
^{243}Cm	2.85E-08	5.13E-08
^{244}Cm	1.52E-07	5.13E-08
Total HDW alpha	0.0541	
Normalization factor	0.337	

Notes:

[1]Agnew et al. (1997a), converted to dry weight basis.

[2]The adjusted concentration was calculated by ratio from HDW values.

[3]From Table D3-14

[4]Not an alpha emitter. The calculation was based on the HDW ratio of ^{241}Pu to ^{240}Pu.

Table D3-16. Radionuclide Inventory of BSltCk Waste in Tank 241-BX-110.

				Comments
kgal	23			
kL	87			
Density, μg/g	1.83			Mean of core 198, segments 2, 2A, 3, and 4
kg	1.59E+05			
% Water	36.3			Mean of core 198, segments 2, 2A, 3, and 4
	Concentration		Inventory	
Radionuclide[2]	μCi/g dry	μCi/g wet	Ci	Comments
^{90}Sr	80.5	51.3	8,145	Average of other BSltCk tanks[1]
^{90}Y	80.5	51.3	8,145	Assume secular equilibrium with ^{90}Sr.
^{137m}Ba	37.1	23.7	3,756	Assume secular equilibrium with ^{137}Cs
^{137}Cs	39.2	25.0	3,970	Average of other BSltCk tanks[1]
^{232}U	4.93E-08	3.14E-08	4.98E-06	Uranium normalization
^{233}U	2.39E-09	1.52E-09	2.42E-07	Uranium normalization
^{234}U	0.00233	0.00148	0.236	Uranium normalization
^{235}U	1.05E-04	6.66E-05	0.0106	Uranium normalization
^{236}U	2.16E-05	1.38E-05	0.00219	Uranium normalization
^{238}Pu	9.01E-05	5.74E-05	0.00912	Alpha normalization
^{238}U	0.00237	0.00151	0.239	Uranium normalization
^{239}Pu	0.0165	0.0105	1.67	Alpha normalization
^{240}Pu	0.00128	8.19E-04	0.130	Alpha normalization
^{241}Am	3.15E-04	2.01E-04	0.0319	Alpha normalization
^{241}Pu	0.00189	1.21E-03	0.191	Alpha normalization
^{242}Cm	4.73E-07	3.02E-07	4.79E-05	Alpha normalization
^{242}Pu	1.41E-08	8.97E-09	1.42E-06	Alpha normalization
^{243}Am	2.20E-09	1.40E-09	2.22E-07	Alpha normalization
^{243}Cm	4.73E-07	3.02E-07	4.79E-05	Alpha normalization
^{244}Cm	5.13E-08	3.27E-08	5.19E-06	Alpha normalization

Notes:

[1]Adjusted for density of 1.83 g/cm^3 and 38.3 percent moisture content to agree with physical properties of core 198, segment 2, upper and lower half, segments 3, and 4.

[2]Radionuclides decayed to January 1, 1994.

D3.5.3 Radionuclide Inventory of BYSltCk Layer

Available sample results for the BYSltCk waste layer include total alpha for the core 197 samples. Uranium, ^{137}Cs, and $^{89/90}Sr$ results are available for other tanks containing the same waste type. The ^{137}Cs, and $^{89/90}Sr$ concentrations are obtained from Table D3-4 for other wastes containing BSltCk. Uranium, plutonium, americium, and curium isotopes are estimated by the alpha normalization of the uranium sample results for other tanks containing BYSltCk and the total alpha results for core 197-1 in the same manner as described in the foregoing discussion concerning the BSltCk alpha-emitting isotope inventory. Because the total alpha concentration was below detection limits for core 197, sections 2 and 2A, only the core 197, section 1 total alpha result is used in the calculations. The remainder of the radionuclide concentrations are obtained from the HDW model. The concentrations then are adjusted for the water content of core 197, segments 1, 2, and 2A. The inventory of each radionuclide is then the product of the volume of the waste layer, the radionuclide concentration, and the density. Table D3-17 shows the resulting BYSltCk radionuclide inventory.

Table D3-17. Radionuclide Inventory of BYSltCk Waste for Tank 241-BX-110. (2 sheets)

				Comments
kgal	42			
kL	159			
Density, g/cm^3	1.74			Mean of core 197, segments 1, 2, and 2A
kg	2.76E+05			Product of volume and density
% Water	36.2			Mean of core 197, segment 1, 2, and 2A
	Concentration		Inventory	
Radionuclide[2]	μCi/g dry	μCi/g wet	Ci	Comments
^{90}Sr	30.04	19.1	5,280	HDW model BYSltCk[1]
^{90}Y	30.0	19.1	5,280	Assume secular equilibrium with ^{90}Sr[1]
^{137m}Ba	109	69.4	19,200	Assume secular equilibrium with ^{137}Cs
^{137}Cs	115	73.4	20,300	Average of other BYSltCk tanks[1]
^{231}Pa	9.57E-06	6.11E-06	0.00169	HDW model BYSltCk[1]
^{232}Th	6.12E-05	3.91E-05	0.0108	HDW model BYSltCk[1]
^{233}U	0.00108	6.92E-04	0.191	Uranium normalization
^{234}U	7.70E-05	4.91E-05	0.0136	Uranium normalization
^{235}U	2.83E-06	1.80E-06	4.98E-04	Uranium normalization
^{236}U	2.53E-06	1.62E-06	4.47E-04	Uranium normalization

Table D3-17. Radionuclide Inventory of BYSltCk Waste for Tank 241-BX-110. (2 sheets)

Radionuclide[2] (Cont'd)	Concentration		Inventory	Comments
	µCi/g dry	µCi/g wet	Ci	
^{238}Pu	0.00243	0.00155	0.429	Alpha normalization
^{238}U	5.21E-05	3.32E-05	0.00918	Uranium normalization
^{239}Pu	0.00187	0.00119	0.329	Alpha normalization
^{240}Pu	3.21E-04	2.05E-04	0.0565	Alpha normalization
^{241}Am	9.17E-04	5.86E-04	0.162	Alpha normalization
^{241}Pu	0.00376	0.00240	0.663	Alpha normalization
^{242}Cm	1.18E-08	7.51E-09	2.07E-06	Alpha normalization
^{242}Pu	1.81E-08	1.16E-08	3.20E-06	Alpha normalization
^{243}Am	3.16E-08	2.02E-08	5.57E-06	Alpha normalization
^{243}Cm	3.06E-09	1.95E-09	5.39E-07	Alpha normalization.
^{244}Cm	4.03E-09	2.57E-09	7.11E-07	Alpha normalization

Notes:

[1]Adjusted for density of 1.83 g/cm³ and 38.3 percent moisture content to agree with physical properties of core 198, segment 2, upper and lower half, segments 3, and 4.

[2]Radionuclides decayed to January 1, 1994.

D3.5.4 Radionuclide Inventory of Supernatant Layer

The supernatant comprises only 11 kL (3 kgal) and was not analyzed for radionuclides during the 1995 auger and 1997 core sampling events. However, sample results are available from the 1990 supernatant sampling event (Weiss 1990). In Table D3-18, the radionuclide concentrations reported in Appendix B are adjusted for radioactive decay to a common January 1, 1994, basis of 124 µCi ^{137}Cs per mL and 0.0137 µCi ^{90}Sr per mL. These concentrations are multiplied by the 11 kL (3 kgal) supernatant inventory in Hanlon (1998) for ^{137}Cs and ^{90}Sr inventories of 1,404 Ci and 0.156 Ci, respectively. Daughter isotopes ^{90}Y and ^{137m}Ba are assumed to be in secular equilibrium with their parent isotopes.

D3.5.5 Sample-Based Radionuclide Estimate

A sample-based radionuclide estimate was prepared with the 1997 core sample results. However, since only total alpha results were available, only alpha-emitting radionuclides could be estimated. The alpha normalization results are shown in Table D3-18.

D3.5.6 Summation of Radionuclide Component Estimates

Table D3-18 shows the summation of the individual layer-by-layer radionuclide component estimates. For comparison, the HDW radionuclide inventory and sample-based radionuclide estimates are shown as well. The component radionuclide inventory estimate generally exceeds the HDW model inventory because of the higher density and lower water content found during the core sample event and because the component inventory uses the Hanlon (1998) tank volume. The uranium and plutonium estimates exceed the HDW model by one or more orders of magnitude, reflecting the results of the 1978 core sample event used to characterize the 1C layer. The sample-based estimate is far lower, reflecting the small amount of alpha activity found during the 1997 core sample event.

Table D3-18. Estimated Radionuclide Inventory for Tank 241-BX-110.[1,3] (2 sheets)

Radionuclide	1C Ci	BSltCk Ci	BYSltCk Ci	Supernatant Ci	Sum of Layers Ci	HDW Model[2] Ci	Sample Based Ci
^{90}Sr	6,625	8,145	5,280	0.156	20,050	26,900	n/r
^{90}Y	6,625	8,145	5,280	0.156	20,050	27,000	n/r
^{137m}Ba	39,218	3,756	19,166	1,328	63,468	29,800	n/r
^{137}Cs	41,456	3,970	20,260	1,404	67,091	31,500	n/r
^{232}U	3.97E-05	4.98E-06	0.0499	n/r	0.0499	1.51	3.38E-04
^{233}U	1.95E-06	2.42E-07	0.191	n/r	0.191	5.77	0.00130
^{234}U	2.35	0.236	0.0136	n/r	2.603	9.32	0.00209
^{235}U	0.0797	0.0106	4.98E-04	n/r	0.0908	0.412	9.25E-05
^{236}U	0.0179	0.00219	4.47E-04	n/r	0.0205	0.0914	2.05E-05
^{238}Pu	1.14	0.00912	0.429	n/r	1.58	0.581	1.30E-04
^{238}U	2.53	0.239	0.00918	n/r	2.782	9.91	0.00211
^{239}Pu	156	1.67	0.329	n/r	158	38.7	0.00870
^{240}Pu	14.3	0.130	0.0565	n/r	14.5	4.70	0.00106
^{241}Am	0.289	0.0319	0.162	n/r	0.482	7.22	0.00162
^{241}Pu	47.5	0.191	0.663	n/r	48.3	36.5	0.00819
^{242}Cm	8.15E-04	4.79E-05	2.07E-06	n/r	8.65E-04	4.94E-04	1.11E-07
^{242}Pu	2.15E-04	1.42E-06	3.20E-06	n/r	2.20E-04	1.73E-04	3.90E-08
^{243}Am	2.02E-06	2.22E-07	5.57E-06	n/r	7.81E-06	2.46E-04	5.52E-08

Table D3-18. Estimated Radionuclide Inventory for Tank 241-BX-110.[1,3]
(2 sheets)

Radionuclide	1C	BSltCk	BYSltCk	Supernatant	Sum of Layers	HDW Model[2]	Sample Based
	Ci	Ci	Ci	Ci	Ci	Ci	Ci
^{243}Cm	1.67E-05	4.79E-05	5.39E-07	n/r	6.51E-05	1.01E-05	2.27E-09
^{244}Cm	4.79E-05	5.19E-06	7.11E-07	n/r	5.38E-05	5.61E-05	1.26E-08

Notes:

[1]Radionuclides decayed to January 1, 1994.

[2]Agnew et al. (1997a)

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage and disposal.

Chemical and radiological inventory information are generally derived using three approaches: 1) component inventories are estimated using results of sample analyses; 2) component inventories are estimated using the HDW model based on process knowledge and historical information; or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-BX-110 was performed, including the following.

- Analytical data for the 1997 push mode core samples (see Appendix B).

- Analytical data for the 1978 push mode core samples (see Appendix B).

- Analytical and historical model data from five waste tanks (241-BX-107, 241-BX-112, 241-C-110, 241-T-104, and 241-T-107) that contain $BiPO_4$ process 1C solids. These tanks are expected to represent the $BiPO_4$ process 1C waste solids in tank 241-BX-110 and are used as a basis for comparison with the 1978 and 1997 core sample data for the 1C waste layer.

- Analytical data from three waste tanks (241-BY-105, 241-BY-106, and 241-BY-110) that contain BYSltCk waste. These tanks are expected to represent the BYSltCk solids in tank 241-BX-110 and are used as a basis for comparison with the 1997 core sample data for the BYSltCk waste layer.

- Analytical and historical model data from four waste tanks (241-B-104, 241-B-106, 241-B-108, and 241-B-109) that contain BSltCk. These tanks are expected to represent the BSltCk solids in tank 241-B-107 and are used as a basis for comparison with the 1997 core sample data for the BSltCk waste layer.

- An inventory estimate generated by the HDW model (Agnew et al. 1997a).

The results of this evaluation support using a combination of the analytical data from the 1978 and 1997 core samples from tank 241-BX-110 and sample results from other waste tanks as the primary basis for the best-estimate inventory for the tank for the following reasons.

- Sample data, if available, are generally preferable to estimates from tanks with similar wastes or from transfer models.

- The analytical concentrations of components in each of three waste types now estimated to be in the tank (1C, BYSltCk, and BSltCk) generally fall within the ranges observed in other analyses and historical model estimates. However, the sample results for core 198 have characteristics of all three of these waste types and may not be representative of the tank as a whole.

- The results for core 197 are consistent with the BYSltCk layer predicted by the TLM for the corresponding region of the tank.

- The results for the 1978 core sample are consistent with the 1C layer predicted by the TLM for the corresponding region of the tank.

- The results for core 198 core are consistent with the BSltCk layer predicted to reside between the 1C and BYSltCk layers by examination of the waste transfer history (Agnew et al. 1997b).

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. The charge balance approach is consistent with that used by Agnew et al. (1997a).

Mercury inventories for each tank recently have been calculated based on process history (Simpson 1998). The estimate given for tank 241-BX-110 is 49.7 kg of mercury.

Tables D4-1 and D4-2 show the best-basis inventory estimates for tank 241-BX-110. These best-basis inventories are summations of the chemical and radionuclide inventories of the individual 1C, BSltCk, BYSltCk, and supernatant waste types predicted to reside in tank 241-BX-110 from examination of the waste transfer history (Agnew et al. 1997b). The inventory estimates for some chemical components are based on the sample results. For other chemicals, inventory results are partly or entirely based on engineering estimates derived from the average concentration of components in similar tanks. Where no sampling or engineering estimate exists, the HDW model compositions for similar waste types are used. Component concentrations derived from engineering estimates and HDW model derived compositions are adjusted for the density, moisture content, and waste volumes in tank 241-BX-110. Finally, inventories for a small number of components are revised based on process knowledge. Section D3.5 describes the derivation of the chemical inventory. The inventory values in Tables D4-1 and D4-2 are subject to change without notice. Refer to the Tank Characterization Database (LMHC 1998) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997). All radionuclides are reported on a common report date of January 1, 1994, to be consistent with the decay date used in the HDW model. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, have been infrequently reported. Therefore, it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997 and in Watrous and Wootan 1997.) Model-generated values for radionuclides in any of 177 tanks are reported in Agnew et al. (1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result (if available). For a discussion of typical errors between model-derived values and sample-derived values, see Kupfer et al. (1997). As few applicable radionuclide data from the tank 241-BX-110 samples were available, the majority of the radionuclide estimates were derived from reported data for similar tanks and the HDW model. Section D3.5 describes derivation of the radionuclide inventory. Where no sampling or engineering estimate exists, the HDW model radionuclide concentrations for similar waste types are used. Radionuclide concentrations derived from engineering estimates are adjusted for the density, moisture content, and waste volumes in tank 241-BX-110.

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-BX-110 (Effective May 31, 1998).

Analyte	Total Inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	30,900	S/E	
Bi	26,800	S/E	
Ca	2,600	M/E	
Cl	2,080	S/E	
TIC as CO_3	16,600	S/E	
Cr	5,500	S/E	
F	16,600	S/E	
Fe	20,400	S/E	
Hg	49.7	E	Global reconciliation for all tanks, Simpson (1998)
K	949	S/E	
La	183	S/E/M	
Mn	255	S/E/M	
Na	2.65E+05	S/E	
Ni	156	S/E/M	
NO_2	24,100	S/E	
NO_3	3.48E+05	S/E	
OH_{TOTAL}	58,200	C	Charge balance
Pb	452	S/E	
PO_4	1.61E+05	S/E	
Si	11,000	S/E	
SO_4	9,840	S/E	
Sr	482	S/E	
TOC	1,680	S/E	
U_{TOTAL}	8,780	S/E	
Zr	179	S/E	

Note:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based, and C = calculated by charge balance; includes oxides as "hydroxide" not including CO_3, NO_2,NO_3, PO_4, SO_4, and SiO_3. In all cases, the analytical data and model results were adjusted for the moisture content and density found in the corresponding region of tank 241-BX-110 during the 1997 core sampling event.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 Decayed to January 1, 1994 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (Ci)[1]	Basis (S, M, or E)[2]	Comment
^{3}H	21.1	M	
^{14}C	5.47	M	
^{59}Ni	0.596	M	
^{60}Co	5.07	M	
^{63}Ni	59.0	M	
^{79}Se	0.468	M	
^{90}Sr	20,100	S/E	Method varies according to layer (Section D3.5)
^{90}Y	20,100	S/E	Referenced to ^{90}Sr
^{93m}Nb	1.64	M	
^{93}Zr	2.26	M	
^{99}Tc	30.6	M	
^{106}Ru	0.00101	M	
^{113m}Cd	11.8	M	
^{125}Sb	22.7	M	
^{126}Sn	0.700	M	
^{129}I	0.0592	M	
^{134}Cs	0.247	M	
^{137m}Ba	63,500	S/E	Referenced to ^{137}Cs
^{137}Cs	67,100	S/E	
^{151}Sm	1,620	M	
^{152}Eu	0.733	M	
^{154}Eu	85.7	M	
^{155}Eu	44.7	M	
^{226}Ra	2.57E-05	M	
^{227}Ac	3.28E-04	M	
^{228}Ra	0.270	M	
^{229}Th	0.00624	M	
^{231}Pa	0.00163	M	
^{232}Th	0.00998	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-110 Decayed to January 1, 1994 (Effective May 31, 1998). (2 sheets)

Analyte	Total Inventory (Ci)[1]	Basis (S, M, or E)[2]	Comment
^{232}U	0.0499	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{233}U	0.191	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{234}U	2.60	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{235}U	0.0908	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{236}U	0.0205	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{237}Np	0.104	M	
^{238}Pu	1.58	S/E/M	Method varied by layer. See Section D3.5.
^{238}U	2.78	S/E/M	Based on uranium total; uses HDW isotopic ratios.
^{239}Pu	158	S/E/M	Method varied by layer. See Section D3.5.
^{240}Pu	14.5	S/E/M	Method varied by layer. See Section D3.5.
^{241}Am	0.482	S/E/M	Method varied by layer. See Section D3.5.
^{241}Pu	48.3	S/E/M	Method varied by layer. See Section D3.5.
^{242}Cm	8.65E-04	S/E/M	Method varied by layer. See Section D3.5.
^{242}Pu	2.20E-04	S/E/M	Method varied by layer. See Section D3.5.
^{243}Am	7.81E-06	S/E/M	Method varied by layer. See Section D3.5.
^{243}Cm	6.51E-05	S/E/M	Method varied by layer. See Section D3.5.
^{244}Cm	5.38E-05	S/E/M	Method varied by layer. See Section D3.5.

Notes:

[1]All data adjusted for density and water content found during 1998 core sampling event.

[2]S = sample-based, M = HDW model-based, and E = engineering assessment-based.

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997b, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Bell, K. E., J. Franklin, J. Stroup, and J. L. Huckaby, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-106*, WHC-SD-WM-ER-616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Benar, C. J., 1997a, *Tank Characterization Report for Single-Shell Tank 241-C-110*, HNF-SD-WM-ER-367, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Benar, C. J., 1997b, *Tank Characterization Report for Single-Shell Tank 241-B-109*, HNF-SD-WM-ER-677, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Bratzel, D. R., 1980, *Evaluation of Waste Storage Tank Physical and Chemical Characterization Data*, (internal letter 65453-80-265 to F. M. Jungfleisch, September 18), Rockwell Hanford Operations, Richland, Washington.

Field, J. G., and B. A. Higley, 1997, *Tank Characterization Report for Single-Shell Tank 241-B-104*, WHC-SD-WM-ER-552, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending May 31, 1996*, WHC-EP-182-99, Westinghouse Hanford Company, Richland, Washington

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending May 31, 1998*, HNF-EP-0182-112, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Higley, B. A., and J. G. Field, *1997, Tank Characterization Report for Single-Shell Tank 241-B-106*, WHC-SD-WM-ER-601, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Horton, J. E., 1979, *Physical and Chemical Characterization of Core Segment #3, Tank 110BX*, (internal letter 60120-79-024 to D. J. Flesher, February 14), Rockwell Hanford Operations, Richland, Washington.

Jungfleisch, F. M., 1980, *Hanford High-Level Defense Waste Characterization - A Status Report*, RHO-CD-1019, Rockwell Hanford Operations, Richland, Washington.

Kupfer, M. J., and R. T. Winward (Meier Associates), 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-112*, WHC-SD-WM-ER-602, Rev. 0A, Lockheed Martin Hanford Corporation, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C.Simpson, R. A. Watrous, S. L. Lambert, D. E. Place, R. M. Orme, G. L. Borsheim, N. G. Colton, M. D. LeClair, R. T. Winward, and W. W. Schulz, 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

LMHC, 1998, *Best-Basis Inventory*, Tank Characterization Database, May 31, 1998, internet at http://twins.pnl.gov:8001/TCD/main.html, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Nuzum, J. L., 1998, *Tank 241-BX-110, Cores 197 and 198 Analytical Results for the Final Report*, HNF-SD-WM-DP-256, Rev. 0A, Waste Management Federal Services of Hanford, Inc., Richland, Washington.

Sasaki, L. M., 1997a, *Tank Characterization Report for Single-Shell Tank 241-T-104*, HNF-SD-WM-ER-372, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Sasaki, L. M., 1997b, *Tank Characterization Report for Single-Shell Tank 241-T-107*, HNF-SD-WM-ER-382, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Schneider, K. L., 1951, *Flow Sheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

Schreiber, R. D., 1997, *Tank Characterization Report for Single-Shell Tank 241-B-108*, HNF-SD-WM-ER-674, Rev. 0B, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Simpson, B. C., 1998, *Best-Basis Inventory Change Package for Reconciliation of Mercury Values, Change Package #7*, (interoffice memorandum 7A120-98-005 to J. W. Cammann, February 26), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Simpson, B. C., J. G. Field, L. M. Sasaki, 1996a, *Tank Characterization Report for Single-Shell Tank 241-BY-105*, WHC-SD-WM-ER-598, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., R. D. Cromar, and R. D. Schreiber, 1996b, *Tank 241-BY-110 Characterization Report*, WHC-SD-WM-ER-591, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

Weiss, R. L., 1990, (DSI to V. C. Boyles, March 16), Westinghouse Hanford Company, Richland, Washington.

Winkelman, W. D., 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-107*, HNF-SD-WM-ER-539, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-BX-110

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-BX-110

Appendix E provides a bibliography of information that supports the characterization of tank 241-BX-110. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-BX-110 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of Tank 241-BX-110
- IIb. Sampling of 1C Waste Type
- IIc. Sampling of BY Saltcake Waste Type

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories Using Both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into the appropriate sections of material, with an annotation at the end of each reference, or set of references, describing the information source. Where possible, a reference is provided for information sources. A majority of the information listed below may be found in the Lockheed Martin Hanford Corp. Tank Characterization and Safety Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste type information to 1981.

Borsheim, G. L., and B. C. Simpson, 1991, *An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks*, WHC-SD-WM-ER-133, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains estimations of $Fe(CN)_6^{-4}$, ^{137}Cs, and ^{90}Sr for various ferrocyanide-containing tanks.

Jungfleisch, F. M., and B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Describes a model for estimating tank waste inventories using process knowledge; radioactive decay estimates using ORIGEN; and assumptions about waste types, solubility, and constraints.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

- Contains compositions of process stream waste before transfer to 200 Area waste tanks.

Sloat, R. J., 1954, *TBP Plant Nickel Ferrocyanide Scavenging Flowsheet*, HW-30399, General Electric Company, Richland, Washington.

- Contains compositions of process stream waste before transfer to 200 Area waste tanks.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1997, *Waste Status and Transaction Record Summary, WSTRS Rev. 4*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains spreadsheets depicting all known tank additions and transfers.

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains tank fill histories and primary campaign and waste type information to 1981.

Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Shows riser location in relation to tank aerial view and describes each riser and its contents.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

- Assesses riser locations for each tank; not all tanks are included or completed. Also includes an estimate of the risers available for sampling.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Provides thermocouple location and status information for double- and single-shell tanks.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Provides leak detection information for all single- and double-shell tanks. Liquid level, liquid observation well, and drywell readings are included.

Id. Sample Planning/Tank Prioritization

Baldwin, J. H., 1996, *Tank 241-BX-110 Rotary Mode Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-112, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains detailed sampling and analysis scheme for auger samples to be taken from tank 241-BX-110 to address applicable DQOs.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Establishes an approach to determine the priority for tank sampling and characterization and identifies high priority tanks for sampling.

Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order,* as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

- Contains agreement between the U.S. Environmental Protection Agency, U.S. Department of Energy, and Washington State Department of Ecology that sets milestones for completing work on the Hanford Site tank farms.

Grimes, G. W., 1977, *Hanford Long-Term Defense High-Level Waste Management Program Waste Sampling and Characterization Plan*, RHO-CD-137, Rockwell Hanford Operations, Richland, Washington.

- Early characterization planning document.

Homi, C. S., 1996, *Tank 241-BX-110 Tank Characterization Plan,* WHC-SD-WM-TP-382, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Contains tank characterization plan for identifying information needed to address relevant issues concerning short-term safe storage and long-term management of single-shell tank 241-BX-110.

Homi, C. S., 1996, *Vapor Sampling and Analysis Plan*, WHC-SD-WM-TP-335, Rev. 1G, Westinghouse Hanford Company, Richland, Washington.

- Vapor sampling and analysis procedure for 200 Area tanks.

Mulkey, C. H., 1996, *Single-Shell Tank System Waste Analysis Plan*, WHC-EP-0356, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Waste analysis plan for single-shell tanks required by WAC-173-303 and 40 CFR Part 265.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

- Creates the Safety Watch List for the Hanford Site tank farms.

Schreiber, R. D., 1995, *Tank 241-BX-110 Auger Sampling and Analysis Plan*, WHC-SD-WM-TSAP-038, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains detailed sampling and analysis scheme for auger samples to be taken from tank 241-BX-110 to address applicable DQOs.

Schreiber, R. D., 1997, *Tank 241-BX-110 Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-112, Rev. 1A, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains detailed sampling and analysis scheme for auger samples to be taken from tank 241-BX-110 to address applicable DQOs.

Stanton, G. A., 1998, *Baseline Sampling Schedule, Change 98-01*, (internal memorandum 79520-98-001 to Distribution, February 5), Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Provides tank waste sampling schedule through fiscal year 2002 and lists samples taken since 1994.

Winkelman, W. D., M. R. Adams, T. M. Brown, J. W. Hunt, D. J. McCain, and L. J. Fergestrom, 1997, *Fiscal Year 1997-1998 Waste Information Requirements Document*, HNF-SD-WM-PLN-126, Rev. 0A, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements from the *Hanford Federal Facility Agreement and Consent Order*, *Recommendation 93-5 Implementation Plan*, and other requirement sources that are combined with managerial and operational constraints to summarize the TWRS characterization program deliverables for fiscal years 1997 and 1998.

Ie. Data Quality Objectives/Customers of Characterization Data

Bloom, G. R., and Q. H. Nguyen, 1995, *Characterization Data Needs for Development, Design, and Operation of Retrieval Equipment Developed Through the Data Quality Objective Process*, WHC-SD-WM-DQO-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Defines retrieval equipment needs of waste physical property data on various tanks.

Cash, R. J., 1996, *Scope Increase of "Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue" Rev.* 2, (internal memorandum 79300-96-029, to S. J. Eberlein, July 12), Westinghouse Hanford Company, Richland, Washington.

- Identifies organic solvent test needed for all single-shell tanks.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Used to determine if tanks are under safe operating conditions.

Kupfer, M. J., 1995, *Strategy for Sampling Hanford Site Tank Wastes for Development of Disposal Technology*, WHC-SD-WM-TA-154, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains sample strategy to meet pretreatment and disposal data needs and list of tanks to be evaluated.

Meacham, J. E., R. J. Cash, B. A. Pulsipher, and G. Chen, 1995, *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objectives Process*, WHC-SD-WM-DQO-007, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains ferrocyanide program data needs, list of tanks to be evaluated, decision thresholds, and decision logic flow diagram.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains organic solvent program data needs, decision thresholds, and decision logic flow diagram.

Meacham, J. E., A. B. Webb, N. W. Kirch, J. A. Lechelt, D.A. Reynolds, G. S. Barney, D. M. Camaioni, F. Gao, R. T. Hallen, and P. G. Heasler, 1997, *Organic Complexant Topical Report*, HNF-SD-WM-CN-058, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sample analysis results to support organic complexant issue resolution.

Mulkey, L. M., and M. S. Miller, 1997, *Data Quality Objectives for Tank Farms Waste Compatibility Program,* WHC-SD-WM-DQO-001, Rev. 2, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements for addressing compatibility issues usually associated with waste transfers.

Osborne, J. W., J. L. Huckaby, E. R. Hewitt, C. M. Anderson, D. D. Mahlum, B.A. Pulsipher, and J. Y. Young, 1995, *Data Quality Objectives for Generic In -Tank Health and Safety Vapor Issue Resolution*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Used to determine if tank headspaces contain potentially hazardous gases and vapors.

Schreiber, R. D., 1997, *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains organic program data needs, list of tanks to be evaluated, decision thresholds, and decision logic flow diagram.

Sutey, M. J., 1993, *Waste Compatibility Assessment of Tank 241-AN-101 With Tanks 241-BX-110 and 241-BX-111*, (internal letter 7C242-93-029 to S. D. Godfrey, August 3), Westinghouse Hanford Company, Richland, Washington.

- Uses sample analysis results for tank waste compatibility assessment.

Turner, D. A., H. Babad, L. L. Buckley, and J. E. Meacham, 1995, *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue*, WHC-SD-WM-DQO-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Used to categorize organic tanks as "safe," "conditionally safe," or "unsafe" based on fuel and moisture concentrations and to support resolution of the safety issue.

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of tank 241-BX-110

ARHCO, 1976, *Analyses of Tank Farm Sample, Sample No. T4433, Tank: 110BX, Received: 4/19/76*, (internal letter, Supervisor of Analytical Services to J. C. Womack, September 17), Atlantic Richfield Hanford Company Operations, Richland, Washington.

- Contains historical sample analysis results.

Bratzel, D. R., 1980, *Evaluation of Waste Storage Tank Physical and Chemical Characterization Data*, (internal letter 65453-80-265 to F. M. Jungfleisch, September 18), Rockwell Hanford Operations, Richland, Washington.

- Contains historical sample analysis results.

Buckingham, J. S., 1975, *Analyses of Tank Farm Liquid Samples*, (internal letter to W. P. Metz, May 20), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains historical sample analysis results.

Caprio, G. S., 1997, *Vapor and Gas Sampling of Single-Shell Tank 241-BX-110 Using the In-Situ Vapor Sampling System*, HNF-SD-WM-RPT-236, Rev. 0, SGN Eurisys Services Company, Richland, Washington.

- Contains sample analysis results from the April 1996 vapor sampling event.

Evans, J. C., K. H. Pool, B. L. Thomas, K. B. Olsen, J. S. Fruchter, and K. L. Silvers, 1997, *Headspace Vapor Characterization of Hanford Waste Tank 241-BX-110: Results from Samples Collected on 4/30/96*, PNNL-11256, Pacific Northwest National Laboratory, Richland, Washington.

- Contains sample analysis results from April 1996 vapor sample event.

Hardy, D. B., 1998, *45-Day Safety Screening Results and Final Report for Tank 241-BX-110, Auger Samples 95-AUG-045 and 95-AUG-046*, WHC-SD-WM-DP-155, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains sample analysis results from October 1995 auger sample events.

Horton, J. E., 1979, *Physical and Chemical Characterization of Core Segment #3, Tank 110BX*, (internal letter 60120-79-024 to D. J. Flesher, February 14), Rockwell Hanford Operations, Richland, Washington.

- Contains historical sample analysis results from November 1978 core sample event.

Huckaby, J. L., and D. S. Sklarew, 1997, *Screening for Organic Solvents in Hanford Waste Tanks Using Organic Vapor Concentrations*, PNNL-11698, Pacific Northwest National Laboratory, Richland, Washington.

- Contains estimates of organic solvent pool area based on organic vapor sample data.

Jungfleisch, F. M., 1980, *Hanford High-Level Defense Waste Characterization - A Status Report*, RHO-CD-1019, Rockwell Hanford Operations, Richland, Washington.

- Contains historical sample analysis results.

Klem, M. J., 1991, *Vapor Space Sampling Criteria for Single-Shell Tanks Containing Ferrocyanide Waste*, WHC-EP-0424, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains summary of analytical TOC concentration for tanks containing ferrocyanide.

Nuzum, J. L., 1998, *Tank 241-BX-110, Cores 197 and 198 Analytical Results for the Final Report*, HNF-SD-WM-DP-256, Rev. 0A, Waste Management Federal Services of Hanford, Inc., Richland, Washington.

- Contains sample analysis results from May 1997 core sample event.

Starr, J. L., and M. J. Kupfer, 1979, *Sludge Washing Experiments on Synthetic and Actual $BiPO_4$ Process Sludges*, (internal letter 65124-79-161 to K. M. Hodgson, October 4), Rockwell Hanford Operations, Richland, Washington.

- Contains results of sludge washing tests and chemical analyses for 1C waste.

Wegener, D. L., 1990, *HEHF Evaluation of Vapor Space in B/BX Tank Farms*, (internal letter 86123-90-DLW-204 to J. L Ahrens, R. R. Auld, D. J. Bishop, D. O. Dobson, B. L. Hall, G. N. Hanson, D. C. Hartley, W. L. Morris, J. E. Perham, C. M. Winkler, and R. L. Wright, September 4), Westinghouse Hanford Company, Richland, Washington.

- Contains historical vapor sample analysis results.

Weiss, R. L., 1990, (DSI to V. C. Boyles, March 16), Westinghouse Hanford Company, Richland, Washington.

- Contains historical vapor sample analysis results.

IIb. Sampling of 1C Waste Type

Bell, K. E., 1997, *Tank Characterization Report for Single-Shell Tank 241-U-110*, HNF-SD-WM-ER-551, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Bell, K. E., and R. T. Winward, 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-109*, HNF-SD-WM-ER-572, Rev. 0B, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Conner, J. M., 1998, *Tank Characterization Report for Single-Shell Tank 241-B-107*, HNF-SD-WM-ER-723, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Kupfer, M. J., and R. T. Winward, 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-112*, HNF-SD-WM-ER-602, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Place, D. E., 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-108*, HNF-SD-WM-ER-407, Rev. 0C, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Sasaki, L. M., 1997, *Tank Characterization Report for Single-Shell Tank 241-T-104*, HNF-SD-WM-ER-372, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Sasaki, L. M., 1997, *Tank Characterization Report for Single-Shell Tank 241-T-107*, HNF-SD-WM-ER-382, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

Starr, J. L., and M. J. Kupfer, 1979, *Sludge Washing Experiments on Synthetic and Actual $BiPO_4$ Process Sludges*, (internal letter 65124-79-161 to K. M. Hodgson, October 4), Rockwell Hanford Operations, Richland, Washington.

- Contains results of sludge washing tests and chemical analyses for 1C waste.

Winkelman, W. D., 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-107*, HNF-SD-WM-ER-539, Rev. 1A, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about 1C waste type.

IIc. Sampling of BY Saltcake Waste Type

Anantatmula, R. P., 1998, *Tank Characterization Report for Single-Shell Tank 241-BX-111*, WHC-SD-WM-ER-653, Rev. 1, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Baldwin, J. H., 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-112*, HNF-SD-WM-ER-701, Rev. 0, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Buckingham, J. S., 1972, *Exothermic Reactions in ITS Feed Solutions*, (internal memorandum to D. J. Larkin, on March 17), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains differential thermal analysis results and gas chromatography results for ITS feed.

Jo, J., 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-111*, HNF-SD-WM-ER-687, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

McCain, D. J., 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-107*, HNF-SD-WM-ER-637, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Metz, W. P., 1972, *Nitric Acid Neutralization and Concentration of ITS Feed*, (internal memorandum to J. S. Buckingham, on June 2), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains a general chemical analysis of ITS feed.

Winward, R. T., and M. J. Kupfer, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-104*, WHC-SD-WM-ER-608, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Winward, R. T., and M. J. Kupfer, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-105*, WHC-SD-WM-ER-598, Rev. 0A, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Winward, R. T., and M. J. Kupfer, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-106*, WHC-SD-WM-ER-616, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

Winward, R. T., and M. J. Kupfer, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-110*, WHC-SD-WM-ER-591, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information about BY saltcake.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories Using both Campaign and Analytical Information

Agnew, S. F., R. A. Corbin, J. Boyer, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, B. L. Young, R. Anema, and C. Ungerecht, 1996, *History of Organic Carbon in Hanford HLW Tanks: HDW Model Rev. 3*, LA-UR-96-989, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Attempts to account for the disposition of soluble organics and provides estimates of TOC content for each tank.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 4*, LA-UR-96-3860, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains waste type summaries; primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids; and SMM, TLM, and individual tank inventory estimates.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 - 1975*, ARH-CD-601B, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Contains major components for waste types and some assumptions. Purchase records are used to estimate chemical inventories.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-349, Rev. 1, Fluor Daniel Northwest Inc., Richland, Washington.

- Contains summary information for tanks in A, AX, B, BX, BY, and C Tank Farms as well as in-tank photograph collages and inventory estimates.

Geier, R. G., 1976, *Estimated Hanford Liquid Wastes Chemical Inventory as of June 30*, 1976, ARH-CD-768, Atlantic Richfield Hanford Company, Richland, Washington.

- Contains major components for waste types and various tanks and some assumptions.

Klem, M. J., 1988, *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944 - 1980)*, WHC-EP-0172, Westinghouse Hanford Company, Richland, Washington.

- Provides a list of chemicals used in production facilities and support operations that sent wastes to the single-shell tanks. List is based on chemical process flowsheets, essential materials consumption records, letters, reports, and other historical data.

Klem, 1990, *Total Organic Carbon Concentration of Single Shell Tank Waste*, (internal letter 82316-90-032 to R. E. Raymond, April 27), Westinghouse Hanford Company, Richland, Washington.

- Contains an estimate of TOC for various tanks based on sample analysis results.

Kupfer, M. J. and R. T. Winward, 1997, *Tank Characterization Report for Single-Shell Tank 241-BX-110*, HNF-SD-WM-ER-566, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains inventory estimate derived from model and sampling results.

Kupfer, M. J., A. L. Boldt, and M. D. LeClair, 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0A, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a global component inventory for major constituents in the 200 Area waste tanks.

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Plutonium and uranium waste contributions are taken at 1 percent of the amount used in processes. Also compares information on ^{99}Tc from both ORIGEN2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1996, *Tank Waste Source Term Inventory Validation, Vol I, II, and III*, WHC-SD-WM-ER-400, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains a quick reference to sampling information in spreadsheet or graphical form for 24 chemicals and 11 radionuclides for all the tanks.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Supporting Document for the Northeast Quadrant Historical Tank Content Estimate Report for BX Tank Farm*, WHC-SD-WM-ER-311, Rev. 1, Fluor Daniel Northwest, Inc., Richland, Washington.

- Contains summary information for tanks in the BX Tank Farm and detailed information including tank waste level history, tank temperature history, cascade and drywell charts, riser information, in-tank photograph collages, and tank layer model bar chart and spreadsheet.

De Lorenzo, D. S., A. T. DiCenso, D. B. Hiller, K. W. Johnson, J. H. Rutherford, D. J. Smith, and B. C. Simpson, 1994, *Tank Characterization Reference Guide,* WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Summarizes issues surrounding characterization of nuclear wastes stored in Hanford Site waste tanks.

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending May 31, 1997*, HNF-EP-0182-122, Lockheed Martin Hanford Corp.for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a summary of tank waste volumes, Watch List tanks, occurrences, tank integrity information, equipment readings, tank location, leak volumes, and other miscellaneous tank information. Document is updated monthly.

Hewitt, E. R., 1996, *Tank Waste Remediation System Resolution of Potentially Hazardous Vapor Issues*, WHC-SD-TWR-RPT-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Resolves industrial hygiene hazardous vapor concern for Hanford 200 Area tanks.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

- Describes a system of sorting single-shell tanks into groups based on the major waste types contained in each tank.

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Contains in-tank photographs and summaries of the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Assesses the relative dryness of tank wastes.

Kummerer, M., 1995, *Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-SARR-010, Rev. 1. Westinghouse Hanford Company, Richland, Washington.

- Assesses thermal heat load of waste tanks based on temperature surveillance data.

Nguyen, D. M., 1989, *Data Analysis of Conditions in Single-Shell Tanks Suspected of Containing Ferrocyanide*, (internal letter 13314-89-025 to N. W. Kirch, March 2), Westinghouse Hanford Company, Richland, Washington.

- Provides assessment of how ferrocyanide affects tank waste.

Shelton, L. W., 1995, *Chemical and Radionuclide Inventory for Single- and Double-Shell tanks*, (internal memorandum 75520-95-007 to R. M. Orme, on August 8), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Radionuclide Inventories for Single- and Double-Shell Tanks*, (internal memorandum 71320-95-002 to F. M. Cooney, on February 14), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum 74A20-96-30 to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Single-Shell Tanks*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains selected sample analysis tables for single-shell tanks before 1993.

Wegener, D. L., 1990, *HEHF Evaluation of Vapor Space in B/BX Tank Farms*, (internal letter 86123-90-DLW-204 to J. L. Ahrens, R. R. Auld, D. J. Bishop, D. O. Dobson, B. L. Hall, G. N. Hanson, D. C. Hartley, W. L. Morris, J. E. Perham, C. M. Winkler, and R. L. Wright, September 4), Westinghouse Hanford Company, Richland, Washington.

- Contains historical vapor sample analyses results.

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